SOUND TRANSMISSION THROUGH THE WALLS OF LIGHT AIRCRAFT
PRF No. 520-1288-0353

An Investigation of Structure-borne Noise in a Handley Page 137 'Jetstream III' Aircraft

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1. INTRODUCTION

Anyone who has flown in a propeller driven plane has probably experienced the high sound levels characteristic to these aircraft. The modern jet planes which now ferry millions of passengers each year are bigger, faster and quieter in comparison. However with the development of new high efficiency, high speed turboprop aircraft it appears that the jet's dominance of the commercial carrier market may be near an end.

These modern turboprop aircraft will be comparable in size and speed to their turbofan counter parts. In addition such aircraft will offer improved fuel economy, making them an attractive alternative for airline companies. However, if turboprop aircraft are to become acceptable alternatives the aircraft industry must insure passenger acceptance of these new carriers. Insuring acceptance begins with providing the public a safe, comfortable flight. Comfort includes acceptable sound pressure levels in the passenger compartment.

Numerous studies [1-14] have been done investigating the sound fields inside airplane cabins. It was not uncommon to find sound pressure levels as high as 95-100 decibels in propeller aircraft. As part of these studies investigators have experimented with various techniques for attenuating the sound radiated into the cabin. Most of these reports [1-8] have concentrated on the effect that sidewall treatments have on the cabin sound field . Such treatments met with various degrees of success in attenuating airborne noise components. However, as was discussed by Mayes [14], a point was reached where additional treatments were ineffective. In other words, as more and more of the airborne noise was eliminated other sound transmission paths became dominant. These paths have been identified as structureborne paths.

Vibrations, caused by the engines, which travel through the plane structure and are radiated as sound into the passenger compartment are an example of structureborne noise (see figure 1). A study done on a single engine aircraft [13] has shown that, at least in some cases, this may be a major sound source. A second and potentially more important structureborne source for aircraft with wing mounted engines is the interaction of the vortices shed by the propeller tips with the wing. The vibrations caused by this interaction might travel down the wing and cause sound to be radiated into the passenger cabin. In one study [14] it was concluded that this wing/vortex phenomena was a major sound source for engine torque of fifty percent or greater.

The purpose of this study was to measure structureborne noise in one particular aircraft. A test apparatus was set up wherein the relative importance of the wing/vortex sound path could be evaluated. Initial results suggest that structureborne noise may indeed be an important noise causing phenomena at higher frequencies.

2. TEST APPARATUS

A Handley Page-137 Jetstream III, a twin engine turboprop, served as the test bed for this study (see figure 2). It is powered by two Garnet Air Research TPE331-30303B turboprop engines, which have a maximum operating speed of 41730 rpm and a gear down ratio of 20.9:1. With room for eighteen passengers and two crew members the HP137 is considered a small commuter aircraft. During the tests all the passenger seats and interior trim panels were intact.

To study the spatial variations in the sound field, 14 microphones were distributed throughout the passenger cabin. These microphones were fixed to the passenger seats at what would be approximately ear level (see figure 3 for microphone locations and figure 4 for microphone set up). After each test every microphone was individually calibrated with a 124 dB pistonphone operating at 250 Hz.

To study the relative contributions of the noise paths (i.e. airborne vs. structureborne) a number of acoustic and aerodynamic shields were used in various configurations (see figure 5). There two types of shields:

I. Fuselage Shields (acoustic)

II. Wing Shields (aerodynamic)

The fuselage shields were constructed of 3/4" plywood supported by a wooden frame. These shields stood as an acoustic barrier between the engine/propeller and cabin. Their purpose was to attenuate the direct airborne noise incident on the fuselage. They were designed to be free standing so no physical contact with the plane was made. This was done to prevent any direct transmission of vibrational energy from the shields to the plane.

The wing shields (see figure 6) were also constructed of 3/4" plywood but were supported by steel tubing frames. These shields were designed to fit over the wings, without making any physical contact with the wings. The wing shields were intended to act as a physical barrier, thus preventing the aerodynamic pressures of the propeller vortices from interacting with the wing.

Three basic shield configurations were used during the tests. The first set up, designated as test A, was with all shields in place. This is the arrangement seen in figure 7. Since test A represents maximum shielding, one might intuitively assume that it would result in the lowest overall sound pressure levels inside the plane. The second configuration, test C, had all wing shields removed but fuselage shields in place. The bare wings and shielded fuselage would allow the wing/vortex interaction to occur while still attenuating the direct airborne contributions. The last setup, test D, was with all shielding removed (see figure 2). To determine the effects of the various shields the recorded sound pressure levels from the three tests were compared.

Due to the flight unworthiness of the craft the study was restricted to static ground testing. The plane was parked on an isolated concrete platform on the edge of Purdue Airport. The starboard side of the plane faced an open field, thus approaching a semi-anechoic environment. A literature survey [15] suggested that while the concrete surface would cause appreciable changes in the acoustic field around the aircraft, it would not significantly alter the vortices which interacted with the wing as long as a flight condition torque existed. However it is possible that the shields used in this test could have appreciably affected the airflow around the plane. What effect, if any this altered flow pattern could have on the cabin sound field is unknown.

During these ground tests only the starboard engine was run. Running only one engine insured there would be no problem with either destructive or constructive interference complicating the test results. It also made the task of reproducing test conditions easier since only one engine was involved. For every test the engine was set to the same conditions, 96% full power with the propellers at full pitch. The full pitch condition was to insure a large airflow over the wing, similar to that experienced in flight.

Figure 3 shows the experimental setup. A portable, IBM compatible GE personal computer, interfaced with a Nicolet 660A FFT analyzer, controlled the data acquisition procedure. Each microphone in the plane was connected to a 16 channel multiplexer. This multiplexer was interfaced with a small Heathkit microprocessor which would switch channels upon command from the computer. Only one microphone at a time sent data to the Nicolet FFT. When the channel setting was complete the GE computer would start the averaging procedure on the FFT. All results shown in this report were collected using a 1000 Hz frequency range, with 50 averages per microphone and a bandwidth of 2.5 Hz. When the averaging was complete the data was stored on the floppy discs of the GE computer in the form of a power spectra. The entire acquisition time for fourteen microphone measurements was 3 to 4 minutes. Postprocessing, which included converting the voltage data to pressure squared values using appropriate formulas and calibration factors, and performing a wideband analysis on the narrowband data, was done later.

3. TEST RESULTS

The data taken during the tests has been reduced and is presented here.

3.1 Narrowband Spectra

A narrowband spectrum from a typical test is shown in figure 8. A complete collection of narrowband plots can be found in Appendix A. Here the sound pressure level is plotted as a function of frequency. The large peak which occurs at 95 Hz represents the first blade passage tone. Subsequent harmonics of this fundamental frequency are easily distinguished. In general, the fundamental tends to be the highest peak in the spectra, although there are some exceptions.

Another general feature of the narrowband spectra are peaks at approximately 32 and 64 Hz. These represent the fundamental and second harmonic of the propeller shaft rotation.

An additional major peak is centered at approximately 440 Hz. This spectral peak has been attributed to electrical noise generated by the plane's electrical system. Though easily picked out in the narrowband analysis this peak becomes a problem in the broadband data analysis presented later.

It is appropriate at this point to discuss the subject of data variability. It was difficult to repeat results for the same test conditions on different days. The exact reasons for this difficulty can be attributed to a number of factors. The reasons include differences in temperature and humidity. The effects of temperature on the sound field in a plane have been shown to be significant in certain situations [12]. Mostly these effects were limited to the case when a blade tone harmonic, or other sound source, coincided with a modal frequency of the cabin. However for most of the frequency band, the modal density inside the passenger cabin was probably high enough so that no one mode was dominant and the results for a space averaged pressure level using all fourteen microphones should be representative. More likely the cause of data variability was an inability to repeat exact engine conditions. The aircraft itself was an older model and the pilots set the engine controls using engine temperature and torque as a guide. As a result their ability to reproduce engine conditions within desirable tolerances is questionable. Certainly, during one test day, conditions were repeated more closely than on different days. In any case, no study was done to determine the sensitivity of the sound field to engine conditions, though such a test might shed some light on this problem. Only data taken on the same day will be compared.

The variability is most apparent at the blade passage tones, as can be seen by studying the narrow band data in Appendix A. Comparing the spectra from the same microphones with identical test conditions, but on different days one may find variations of up to 7 dB exist between peaks in tests A and C, while test D shows differences of up to 15 dB. These are the largest variations, most differences were substantially lower. The repeatability of the broadband noise levels was quite good. While differences in peaks showed great variability only in a few instances did the changes in the broadband noise exceed 1 or 2 dB.

3.2 Wideband Spectrum

To complement the narrowband study, a wideband analysis was performed in a postprocessing procedure. The wideband data was obtained by summing the pressure squared narrowband data over a bandwidth of 95 Hz and then converting it to a decibel scale. A typical wideband spectrum is shown in figure 9. The complete set of wideband spectra is shown in Appendix B. Even though one loses the ability to identify individual noise sources, the wideband analysis greatly facilitates the comparison of overall test results. The wideband spectra give the total sound pressure level over a wide bandwidth and thus reduce the number of data points one must compare. In addition some of the variations in the narrowband spectra which are due to engine speed changes will be summed.

As with the narrowband study, the difficulty with repeatability is apparent. The situation with the wideband spectra is somewhat better since the wideband spectra sum all the bands around the harmonics. However the data variability in the wideband spectra is still large enough to make it difficult to draw any conclusions about the effects the shielding is having on the local noise reduction at seat locations.

3.3 Global Averaged Wideband Spectrum

To deal further with the problem of data variation, a spatial average of the pressure squared terms was made. In this averaging process the wideband pressure squared terms were averaged over the fourteen microphone locations and then converted to a decibel scale. Figures 10 and 11 show the spatial averaged results from two separate test days.

To illustrate the effects that the different shield configurations had on the overall sound pressure levels, noise reduction (NR) plots were made. Example plots are shown in figures 12 and 13. Any structureborne noise reduction due to the wing/vortex interaction should show up in these figures. The difference calculated by subtracting the noise reduction due to the fuselage shields from the noise reduction due to all the shields should be the noise reduction component due to the wing shields. For example, in figure 12 consider the bandwidth centerline frequency of 760 Hz. The NR due to all the shields is 6 dB while the NR due to the fuselage shields is 4 dB. This means the wing shields are responsible for a NR of 2 dB.

From these figures it is evident that at centerline frequencies of 570 Hz and above the wing/vortex phenomena is indeed a notable noise source. The wing shields are producing noise reductions from 1-3 dB.

The results for lower frequencies, however are not as consistent. In this study it appears that, contrary to the work of Metcalf and Mayes [14], the vortex impingement upon the wing is not a major noise source at the first blade passage frequency.

It was found in the narrowband study that there existed a strong electrical noise source centered at about 440 Hz. This noise source was averaged into the wideband results and dominates the spectra at 380 and 475 Hz. Thus the shields have no effect on the spectra at 380 and 475 Hz and the results should be ignored for these two frequency bands. This could explain why in figure 12 the noise reduction is negative at 380 Hz.

4. CONCLUSIONS

The results from this study indicate that the structureborne noise due to a wing/vortex interaction may be significant at frequencies above 500 Hz for the Handley Page-137 Jetstream III. It was found by preventing such interaction, noise reductions between 1-3 dB were attainable. However this study did not show any significant contribution due to this phenomena at the first blade passage tone. It is suspected that, as suggested by Eversman [16], the wing/vortex interaction effect varies from plane to plane.

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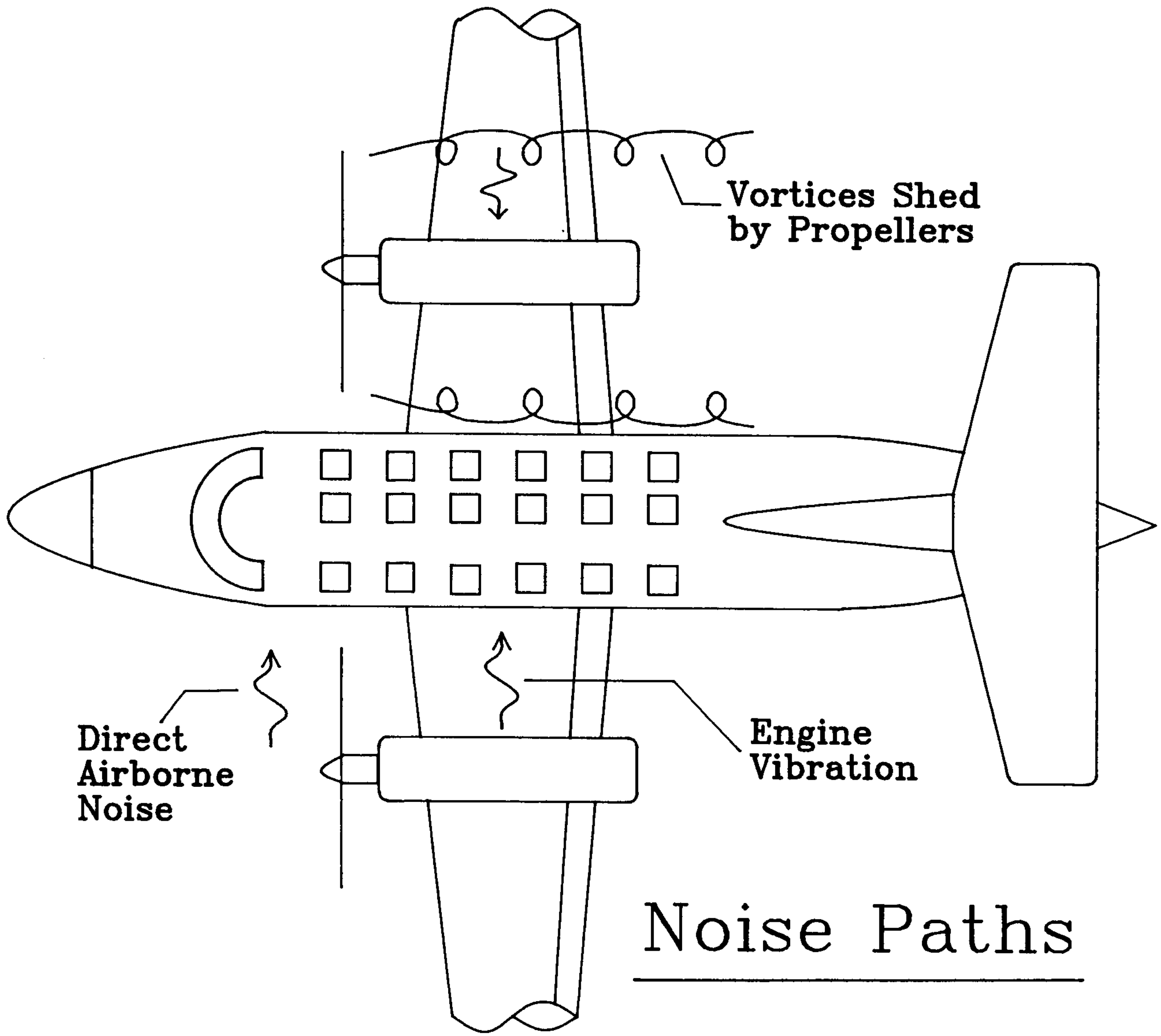

Vortices Shed
by Propellers
Direct
Airborne
Noise
Engine
Vibration
Noise Paths

Figure 1

Figure 2: Handley Page-137 Jetstream III

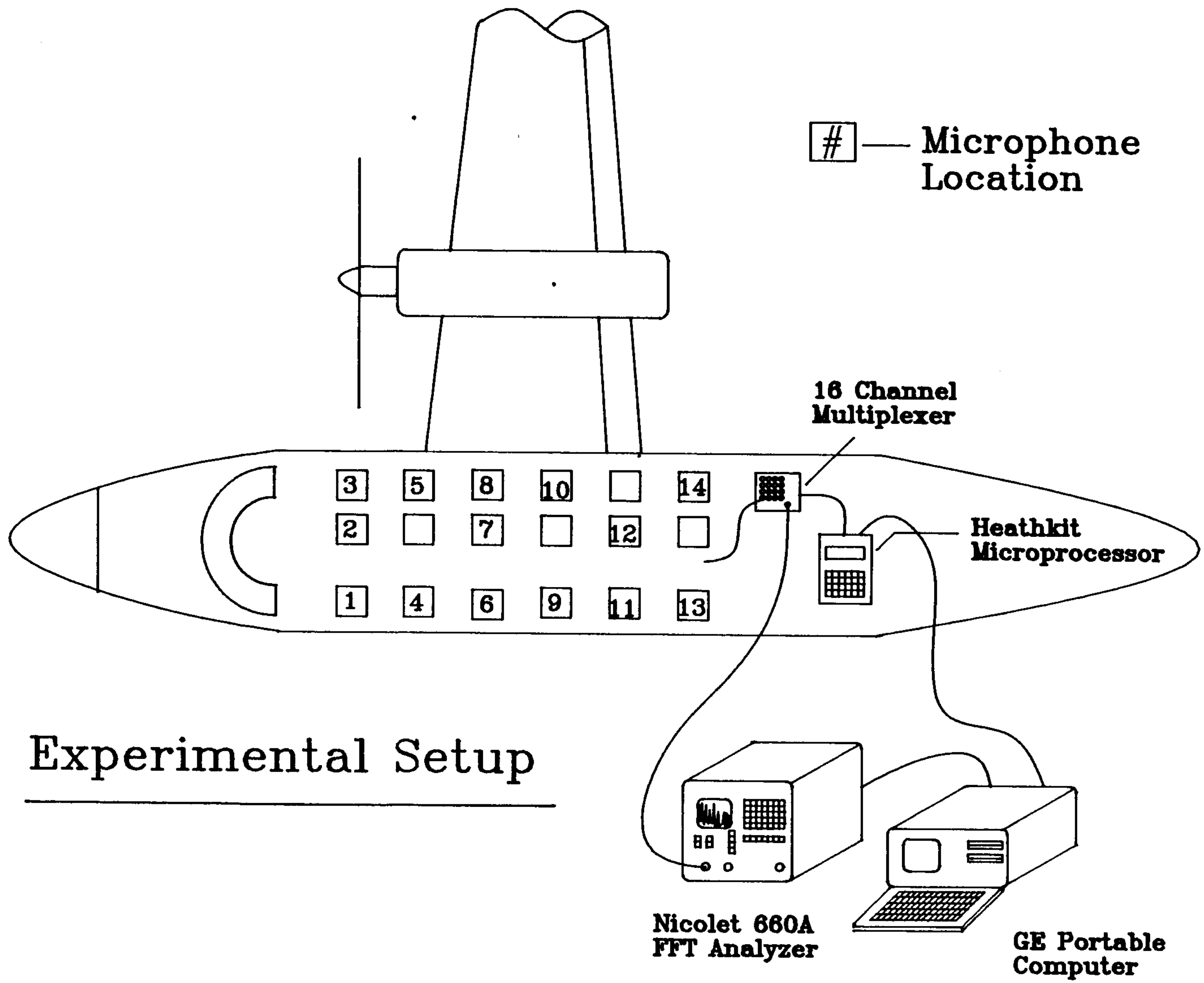

#
Microphone Location
16 Channel Multiplexer
Heathkit Microprocessor
3
5
8
10
14
2
7
12
1
4
6
9
11
13
Experimental Setup
Nicolet 660A FFT Analyzer
GE Portable Computer

Figure 3

Figure 4: Microphone set up inside passenger cabin

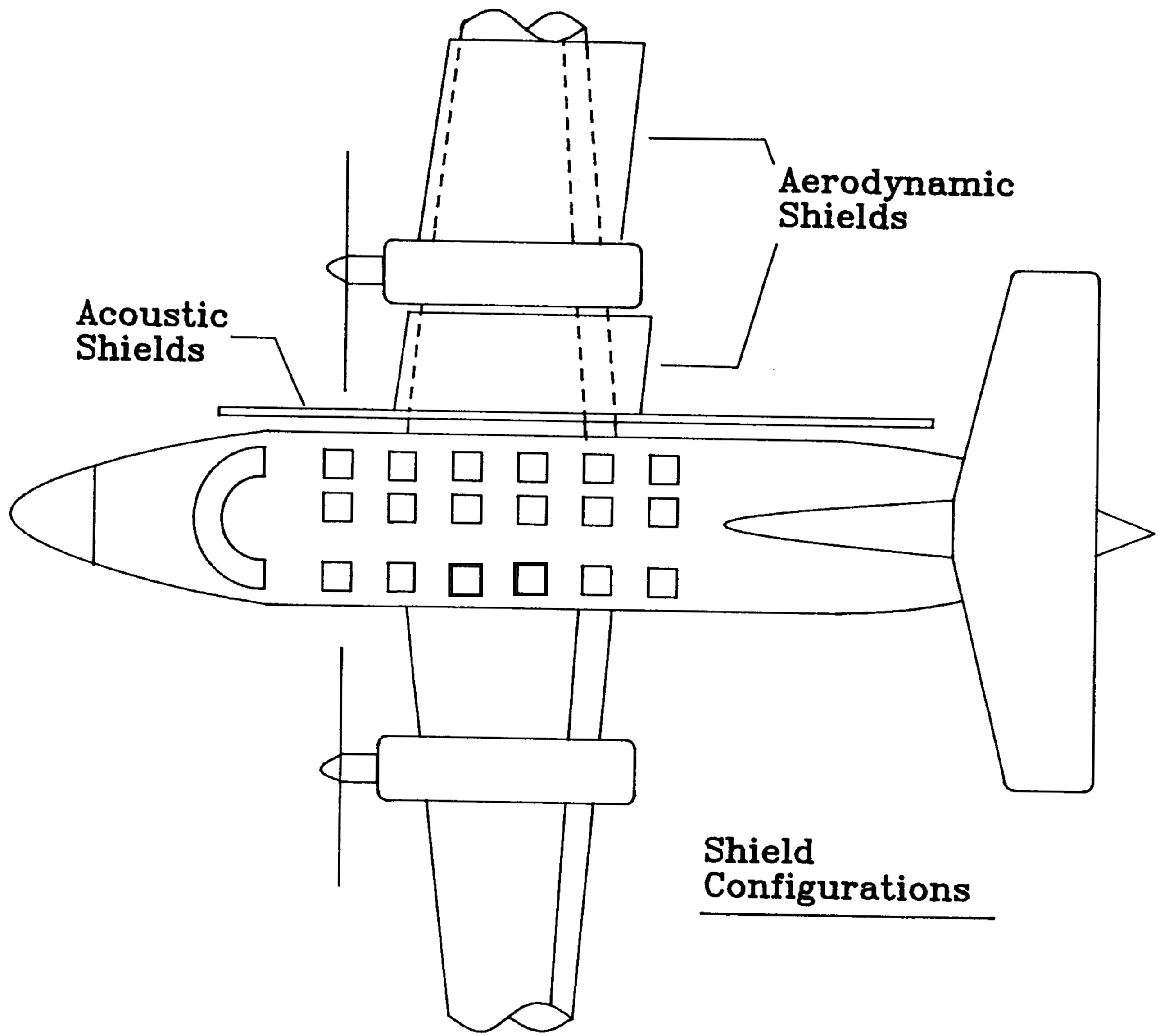

Aerodynamic
Shields
Acoustic
Shields
Shield
Configurations

Figure 5

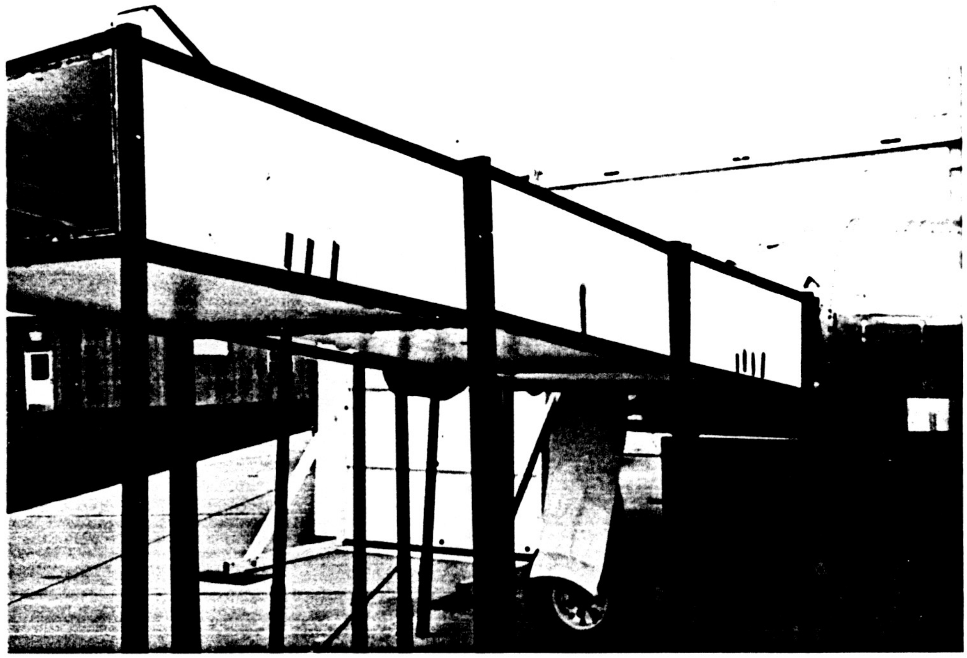


Figure 6: Wing Shields

Figure 7: Test A Configuration

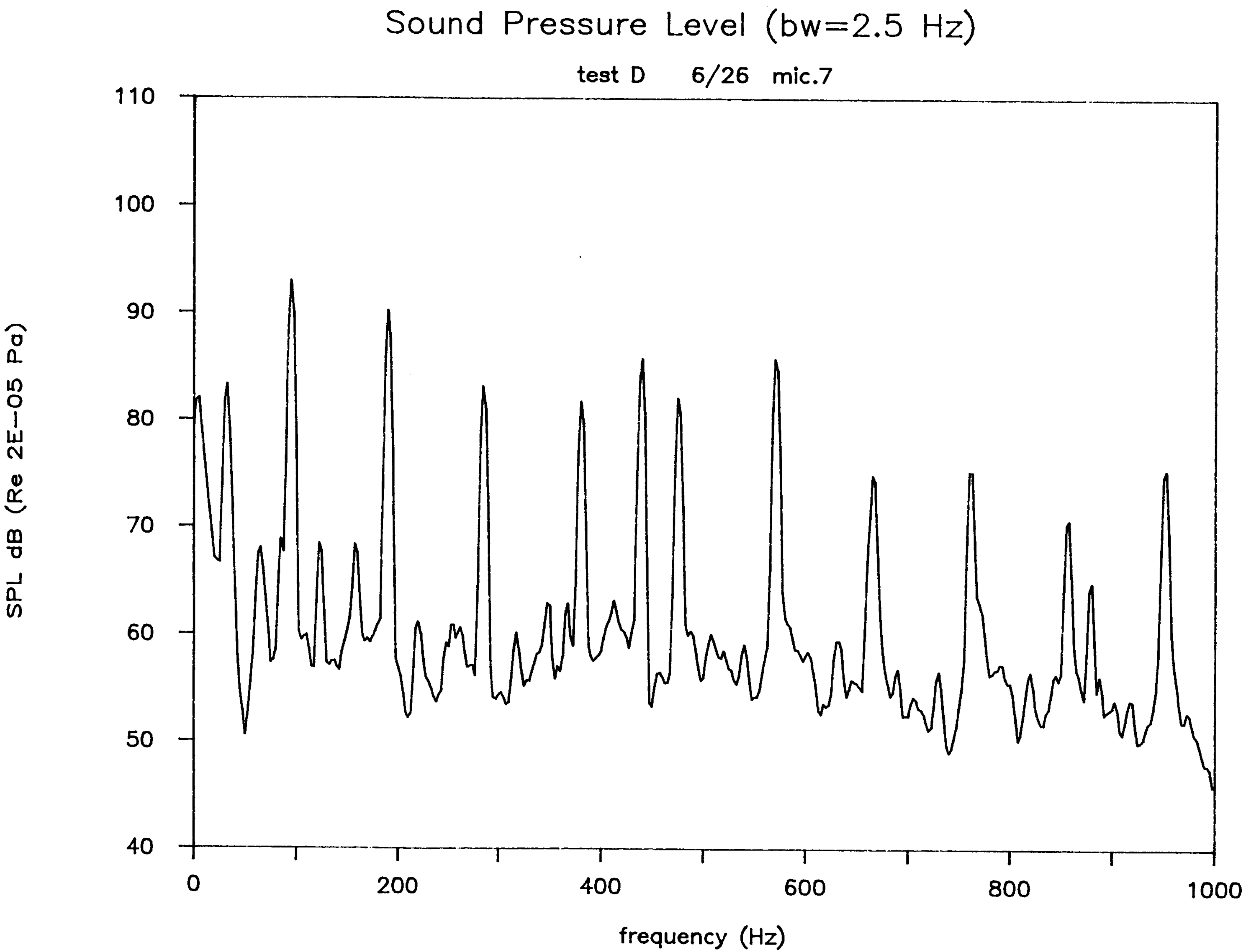


Figure 8: Narrowband Spectrum

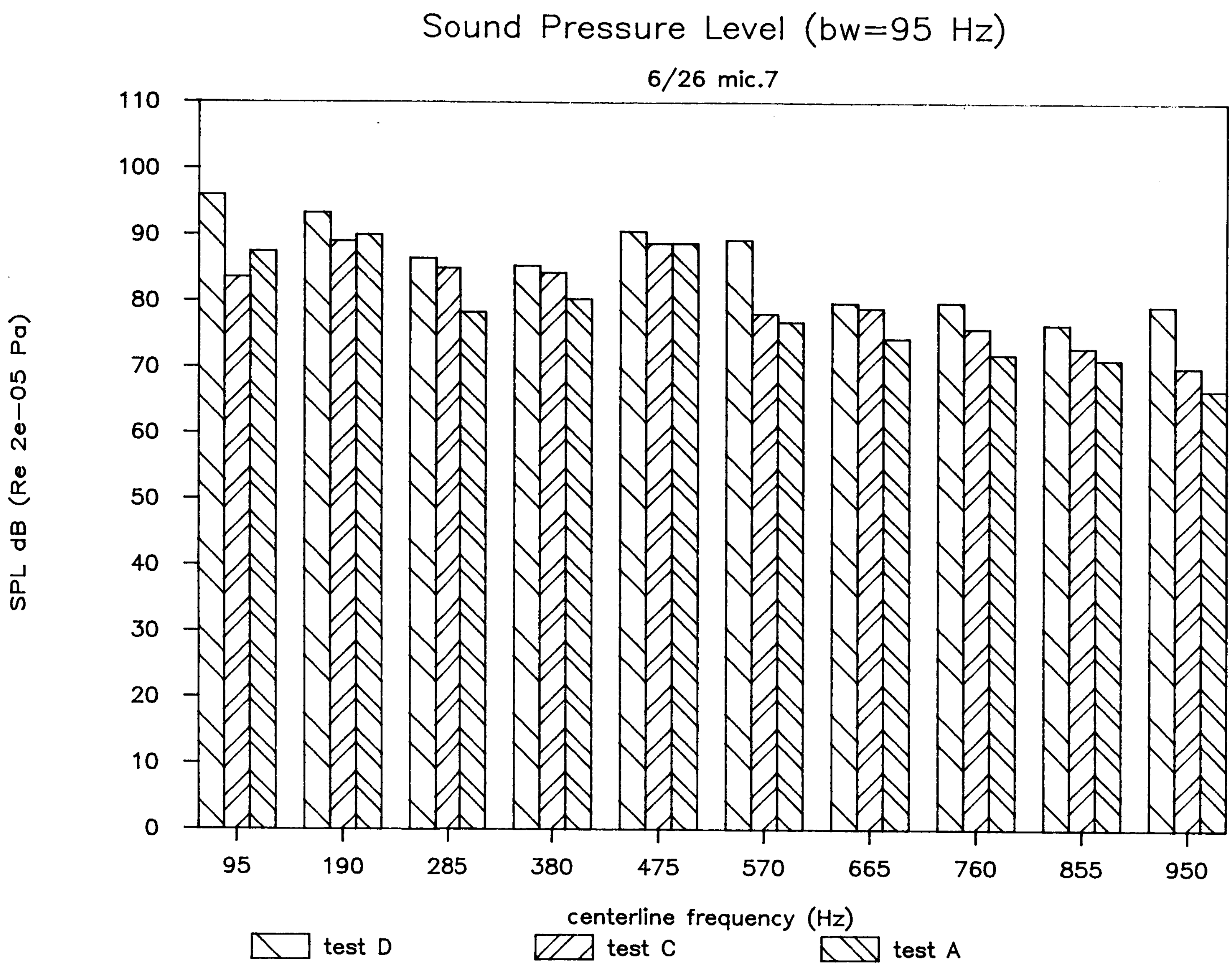


Figure 9: Wideband Spectrum

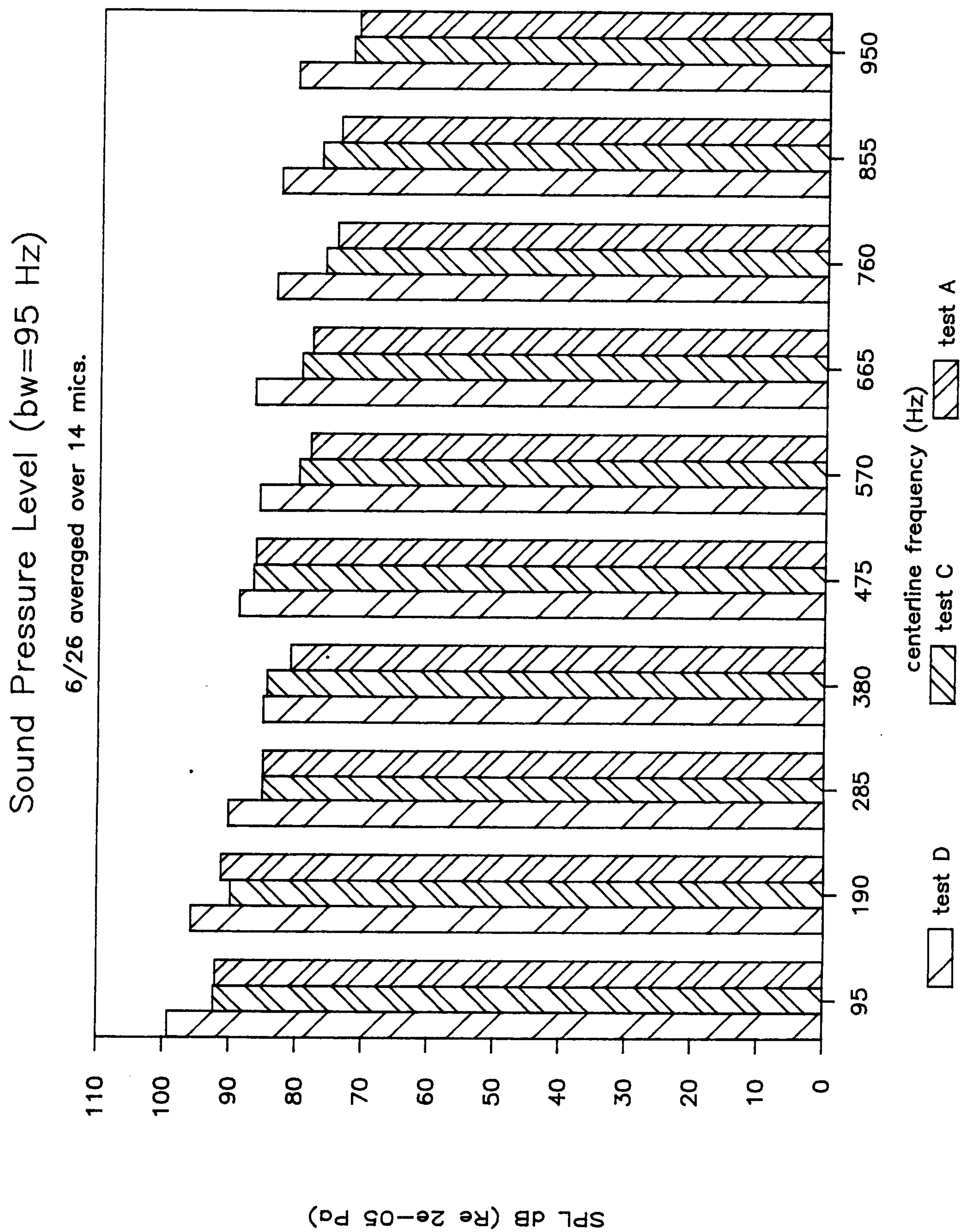


Figure 10: Spatial Averaged Wideband Spectrum

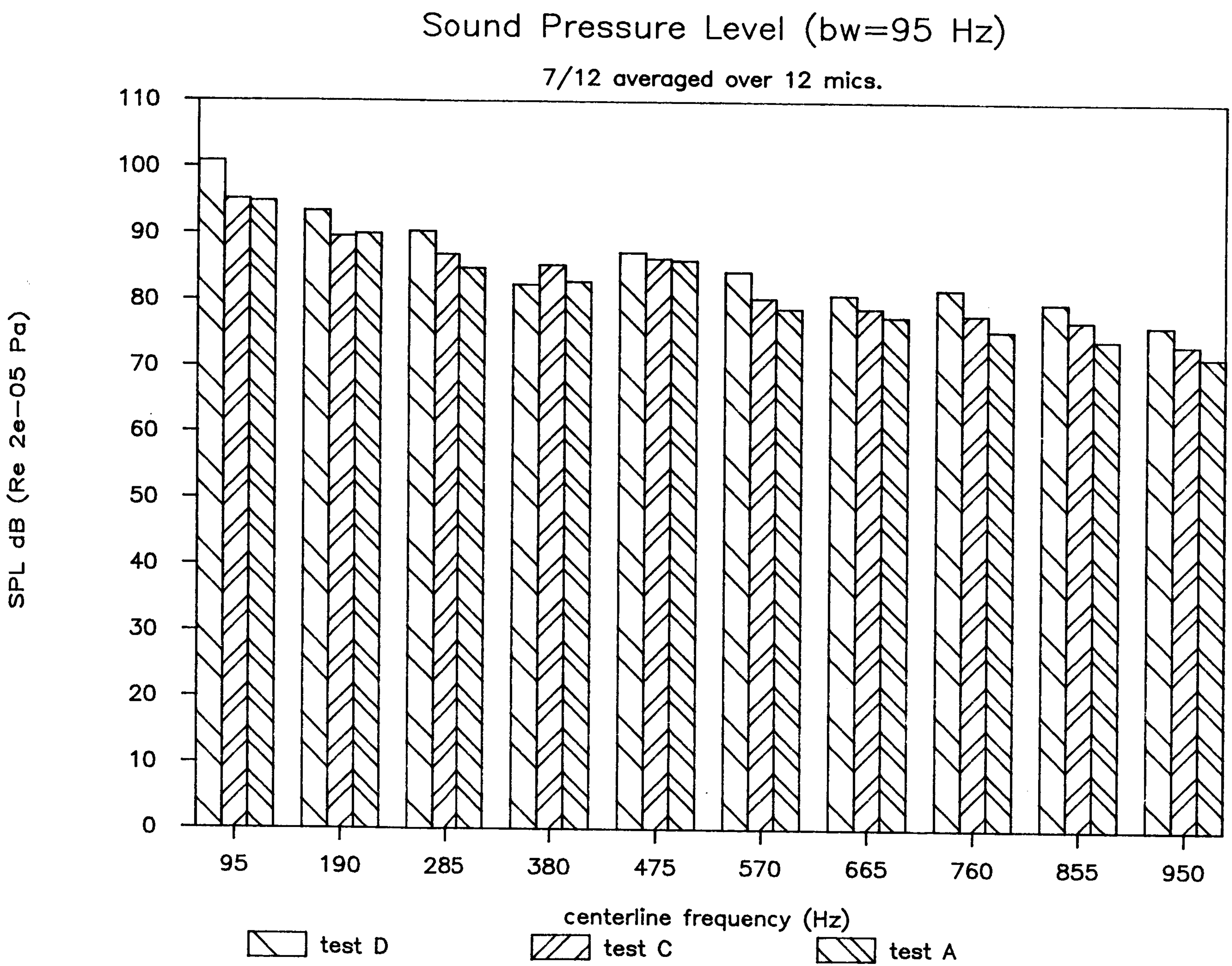
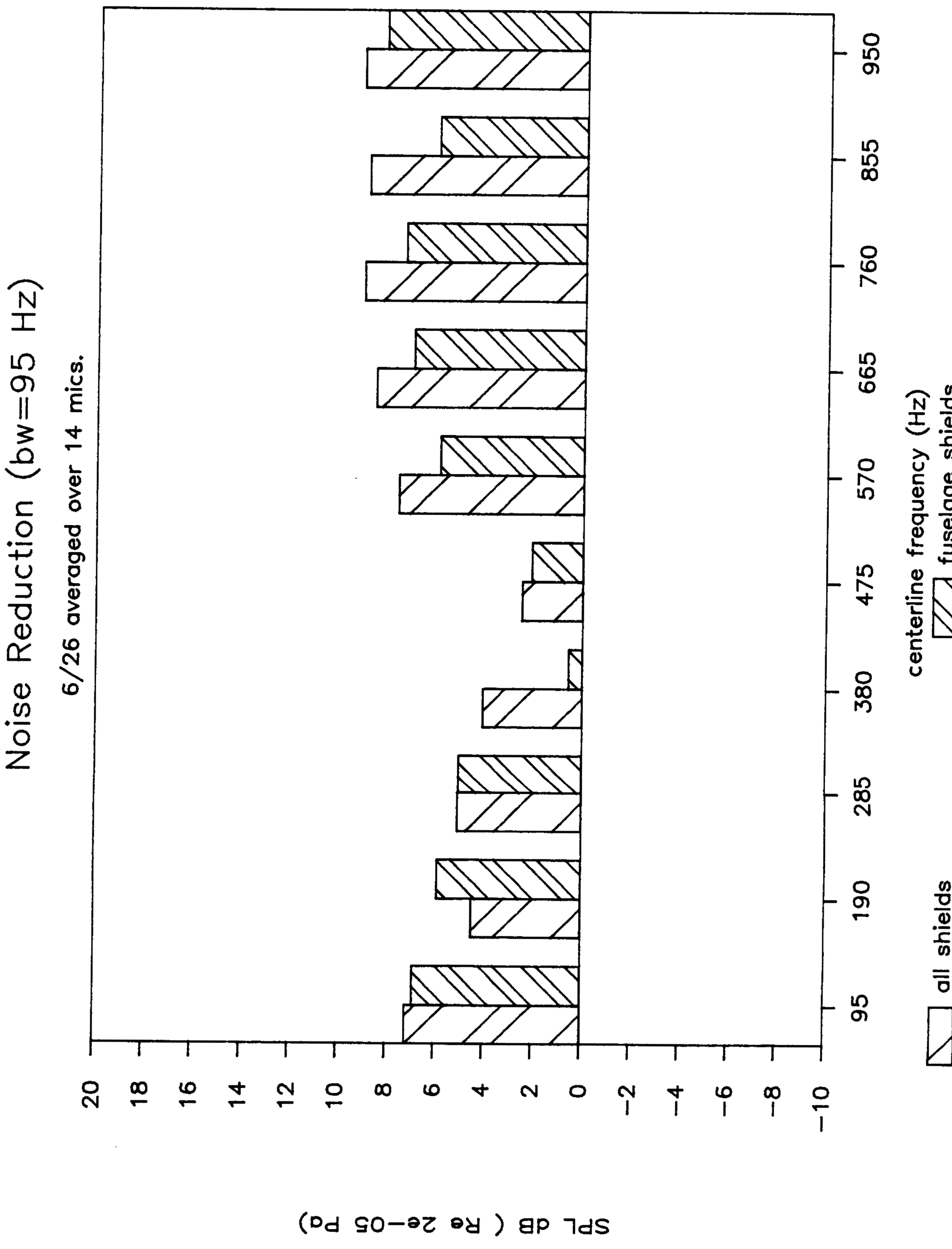
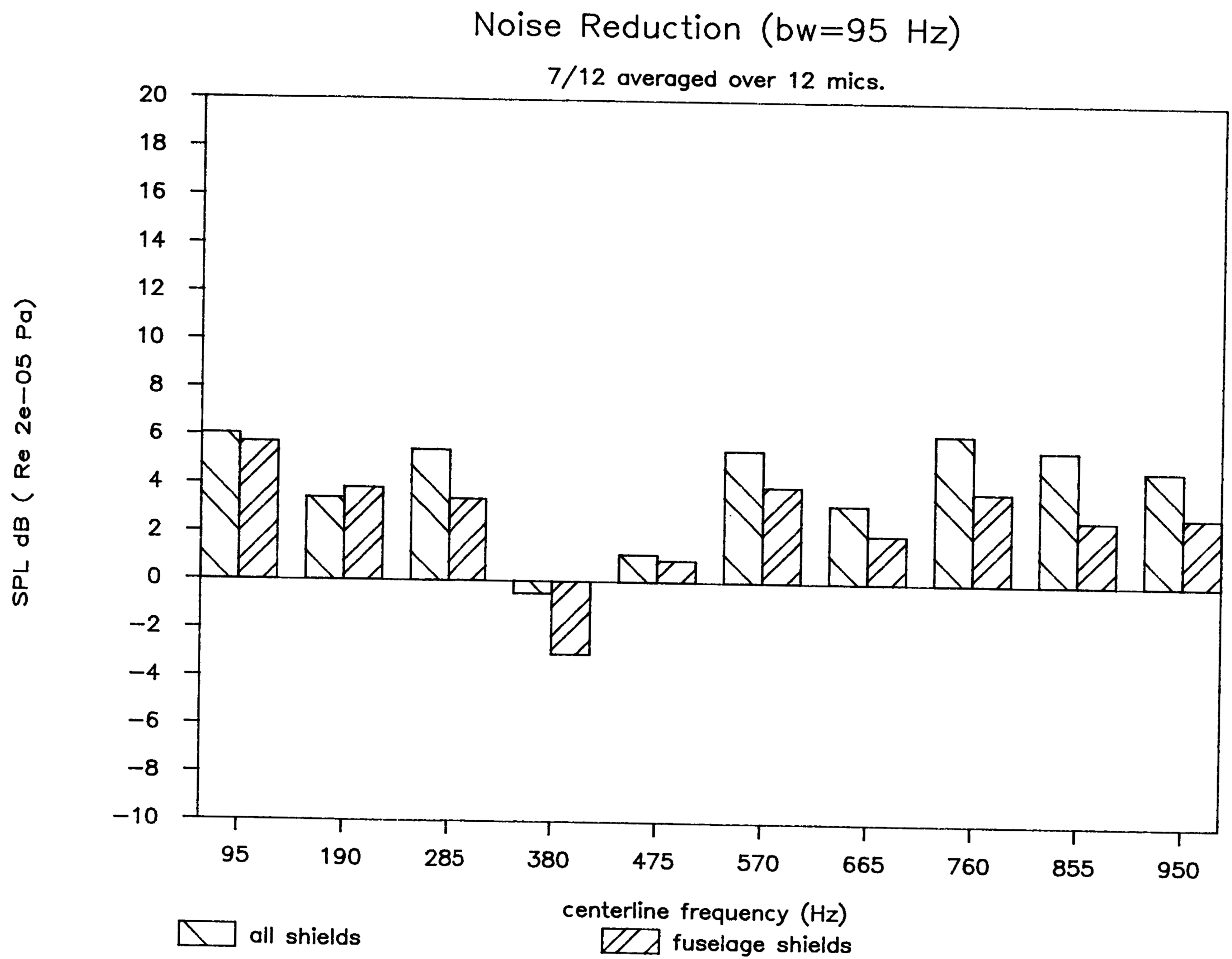


Figure 11: Spatial Averaged Wideband Spectrum



Noise Reduction (bw=95 Hz)
6/26 averaged over 14 mics.
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

Figure 12


Noise Reduction (bw=95 Hz)
7/12 averaged over 12 mics.
SPL dB (Re 2e−05 Pa)
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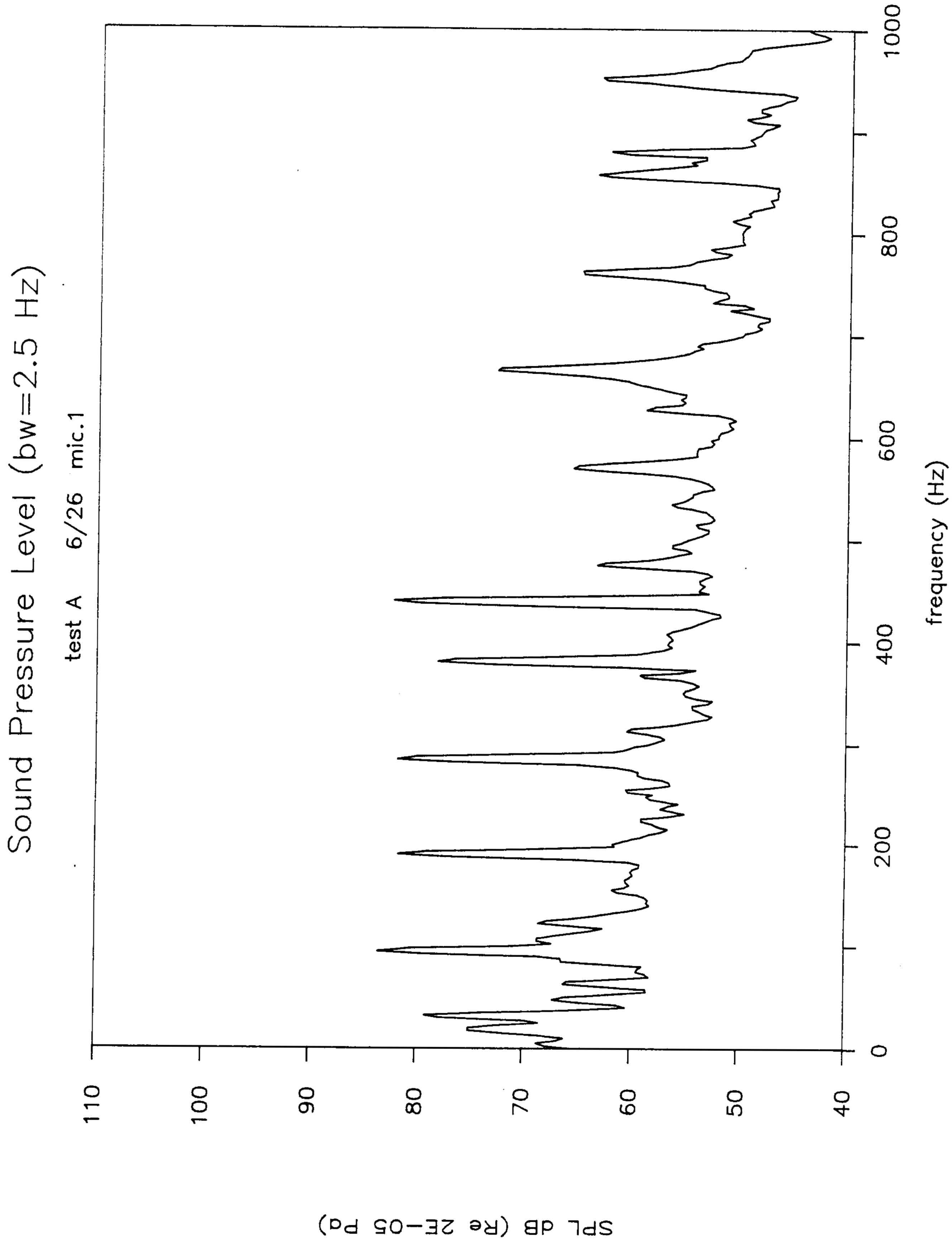
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

Figure 13

APPENDIX A: NARROWBAND SPECTRA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test A 6/26 mic.1
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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600
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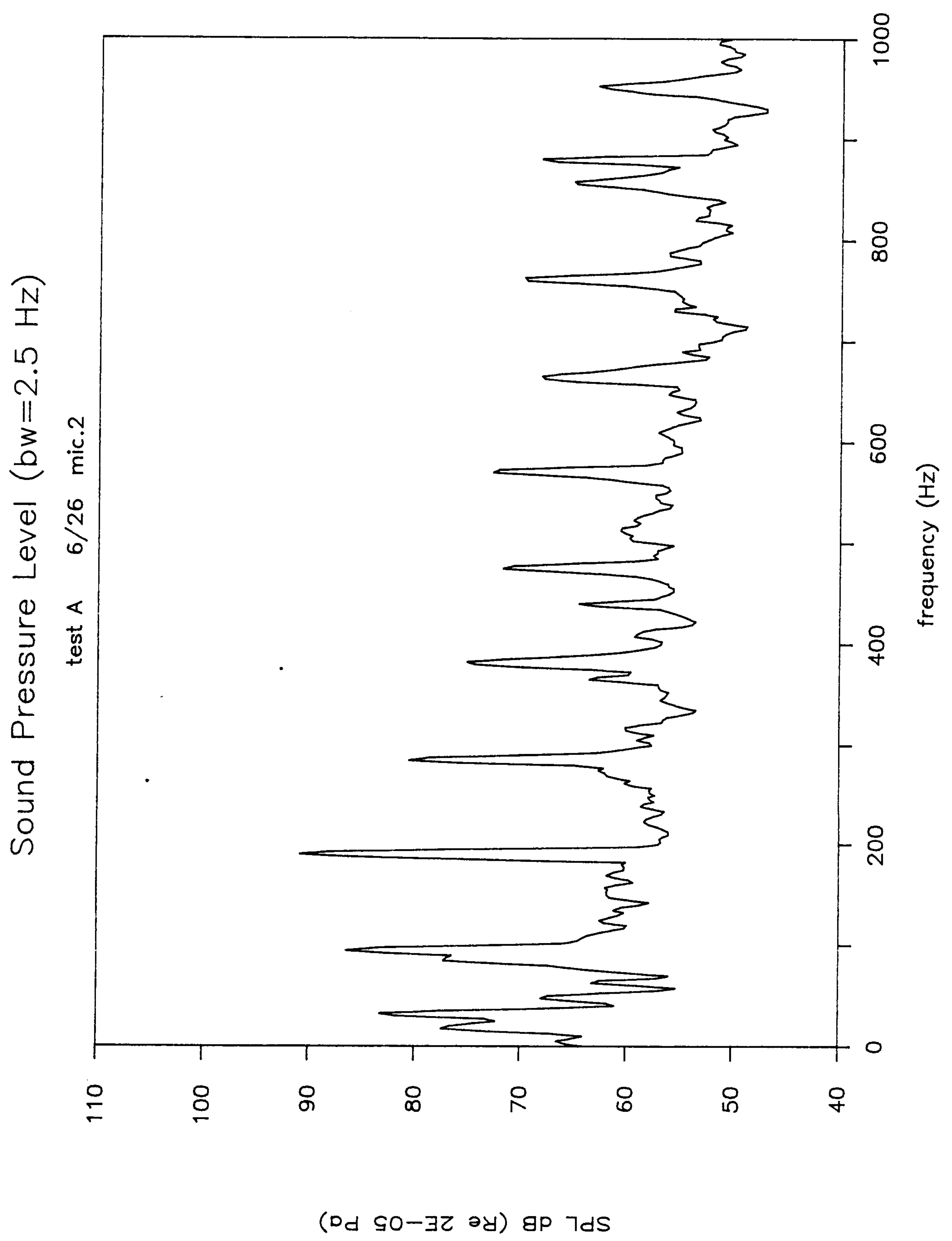
70
80
90
100
110


Sound Pressure Level (bw=2.5 Hz)
test A 6/26 mic.2
SPL dB (Re 2E-05 Pa)
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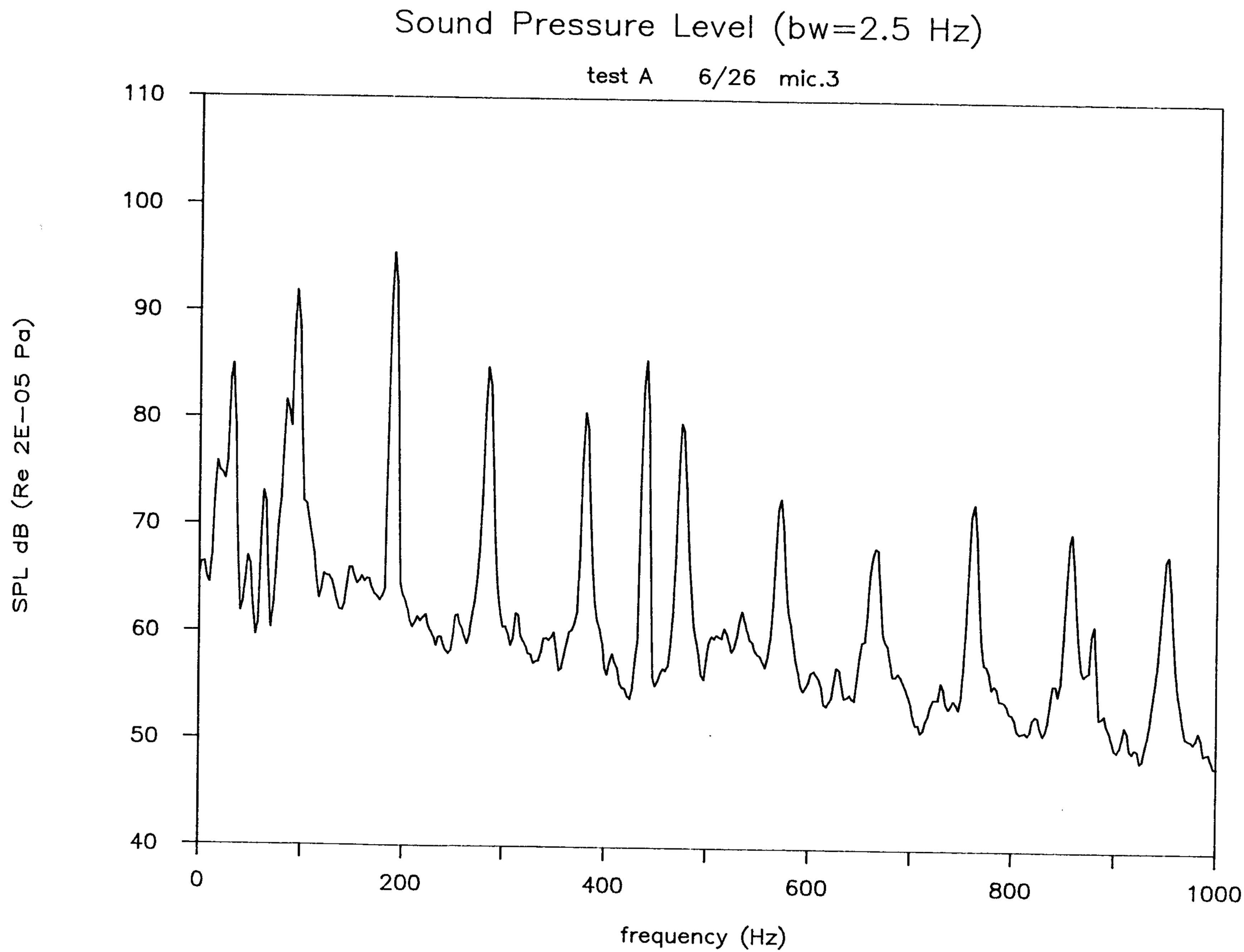
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)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test A 6/26 mic.3
SPL dB (Re 2E-05 Pa)
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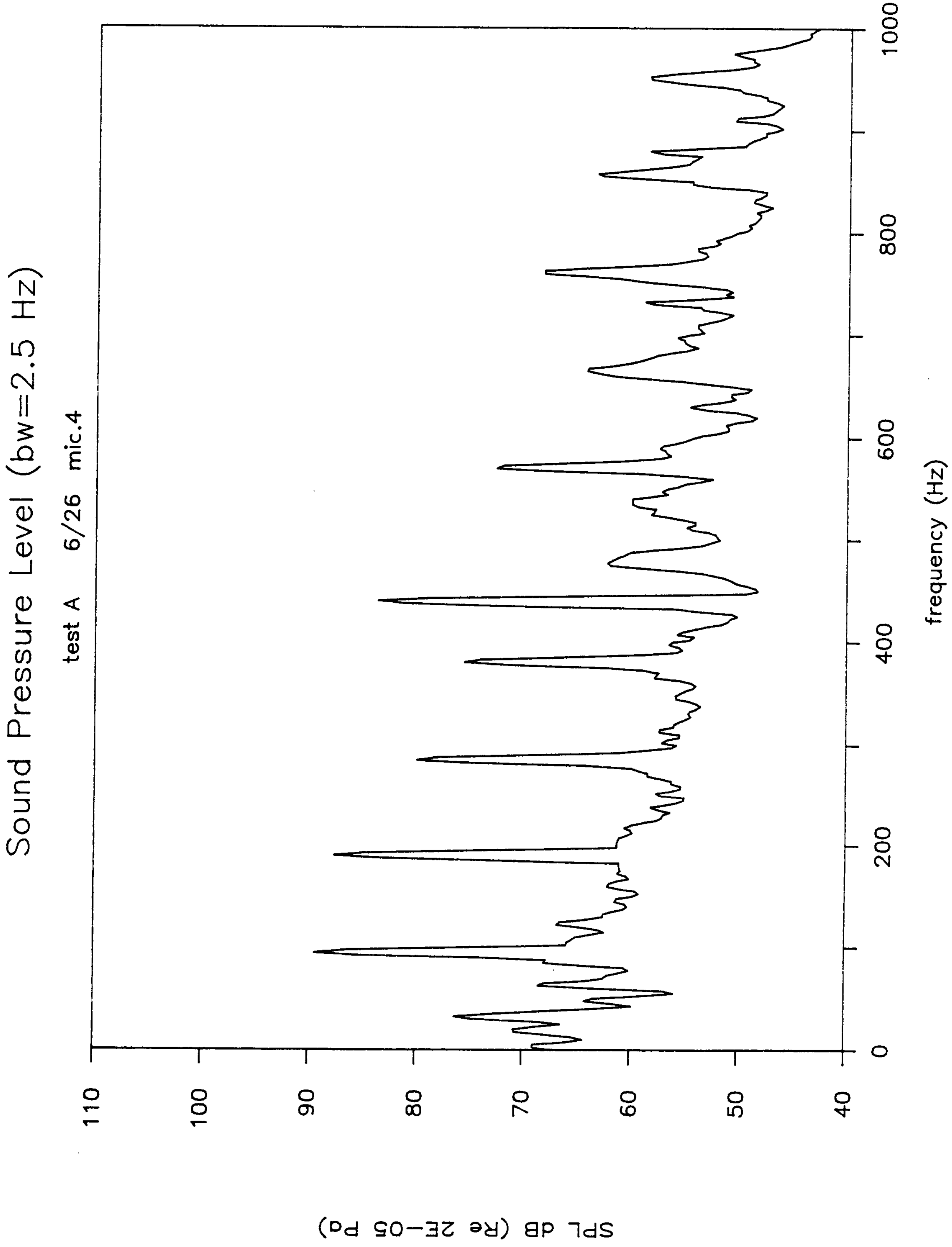
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)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SPL dB (Re 2E-05 Pa)
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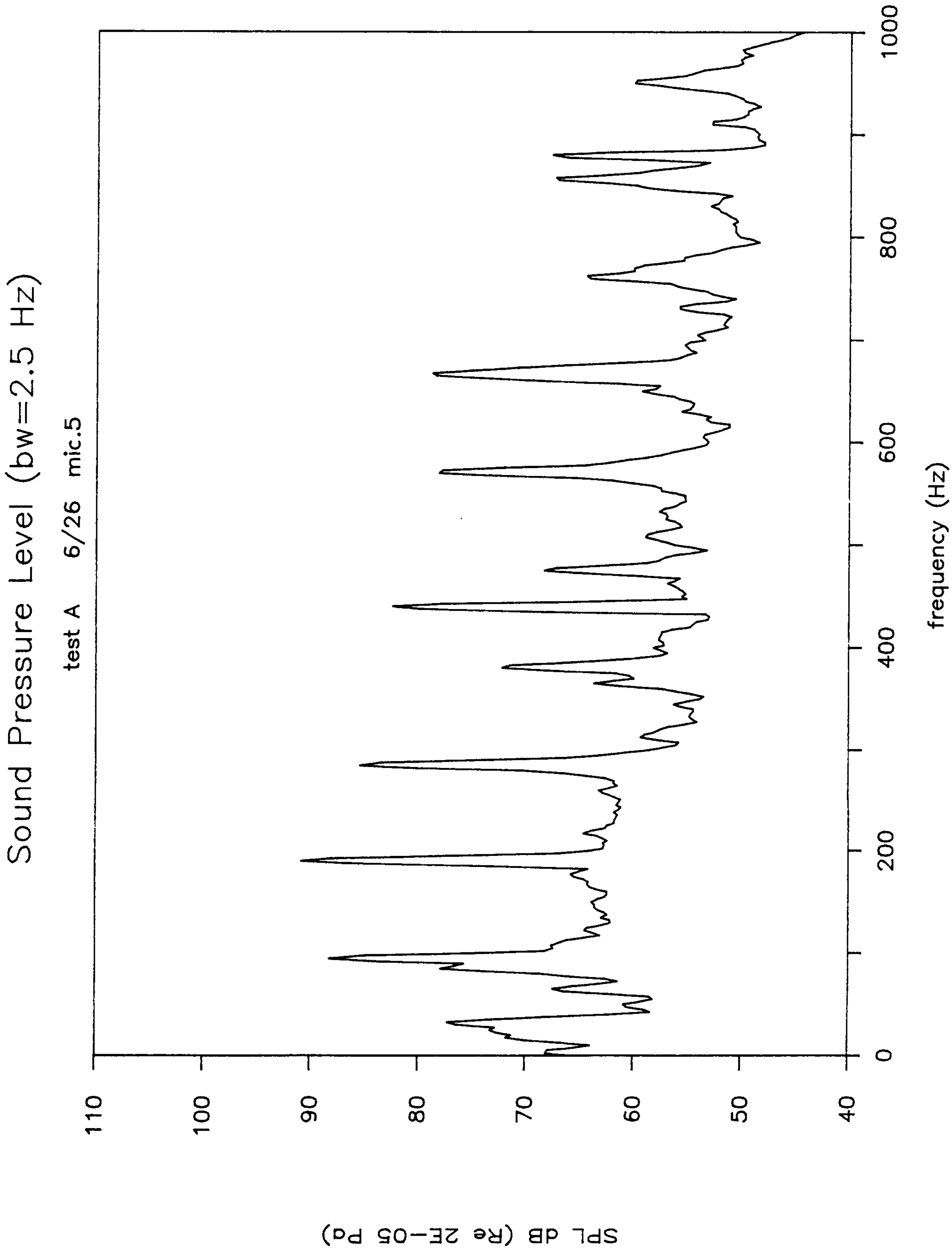
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
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frequency (Hz)
SPL dB (Re 2E-05 Pa)
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600
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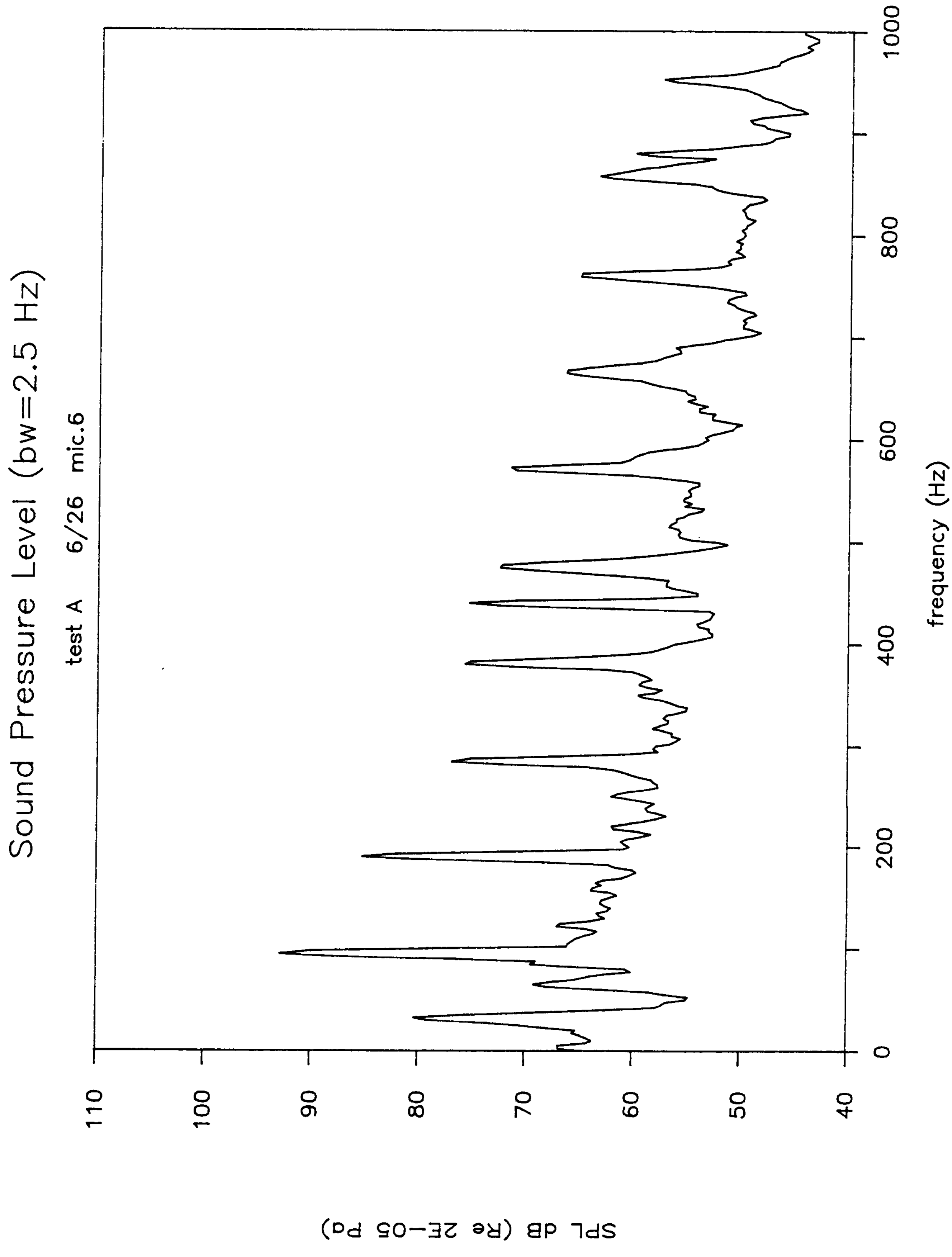
70
80
90
100
110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SPL dB (Re 2E-05 Pa)
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200
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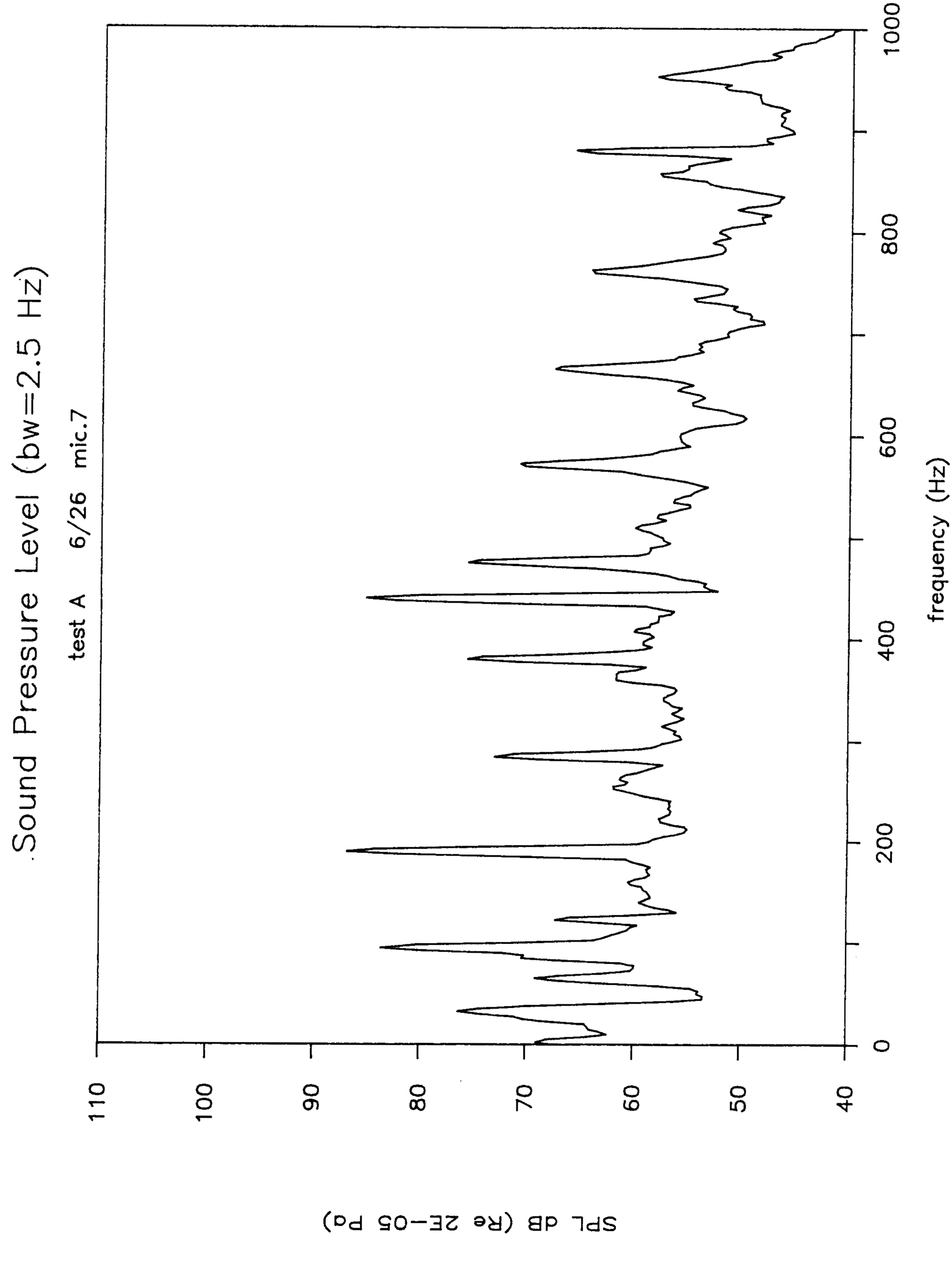
1000
frequency (Hz)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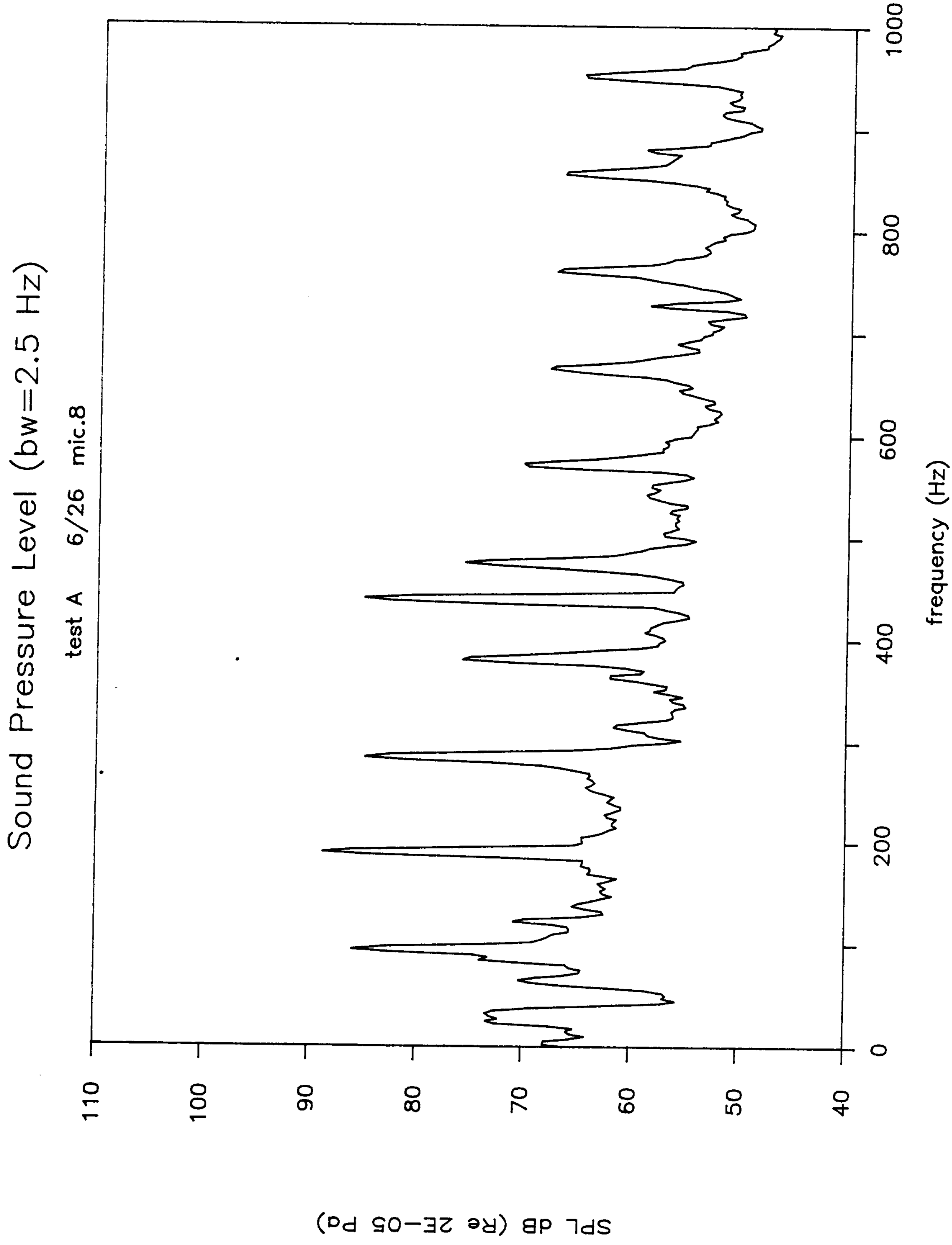
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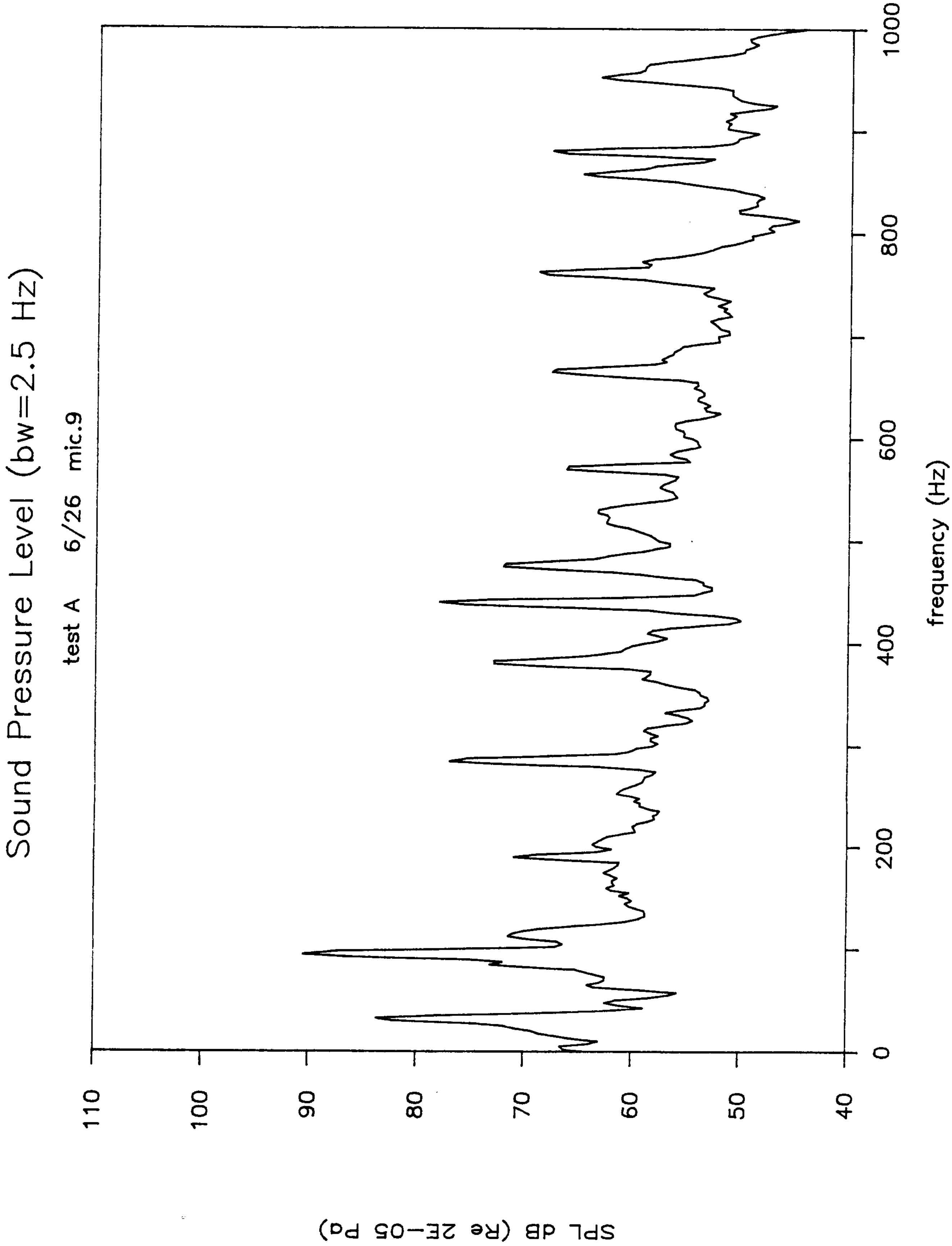
frequency (Hz)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frequency (Hz)
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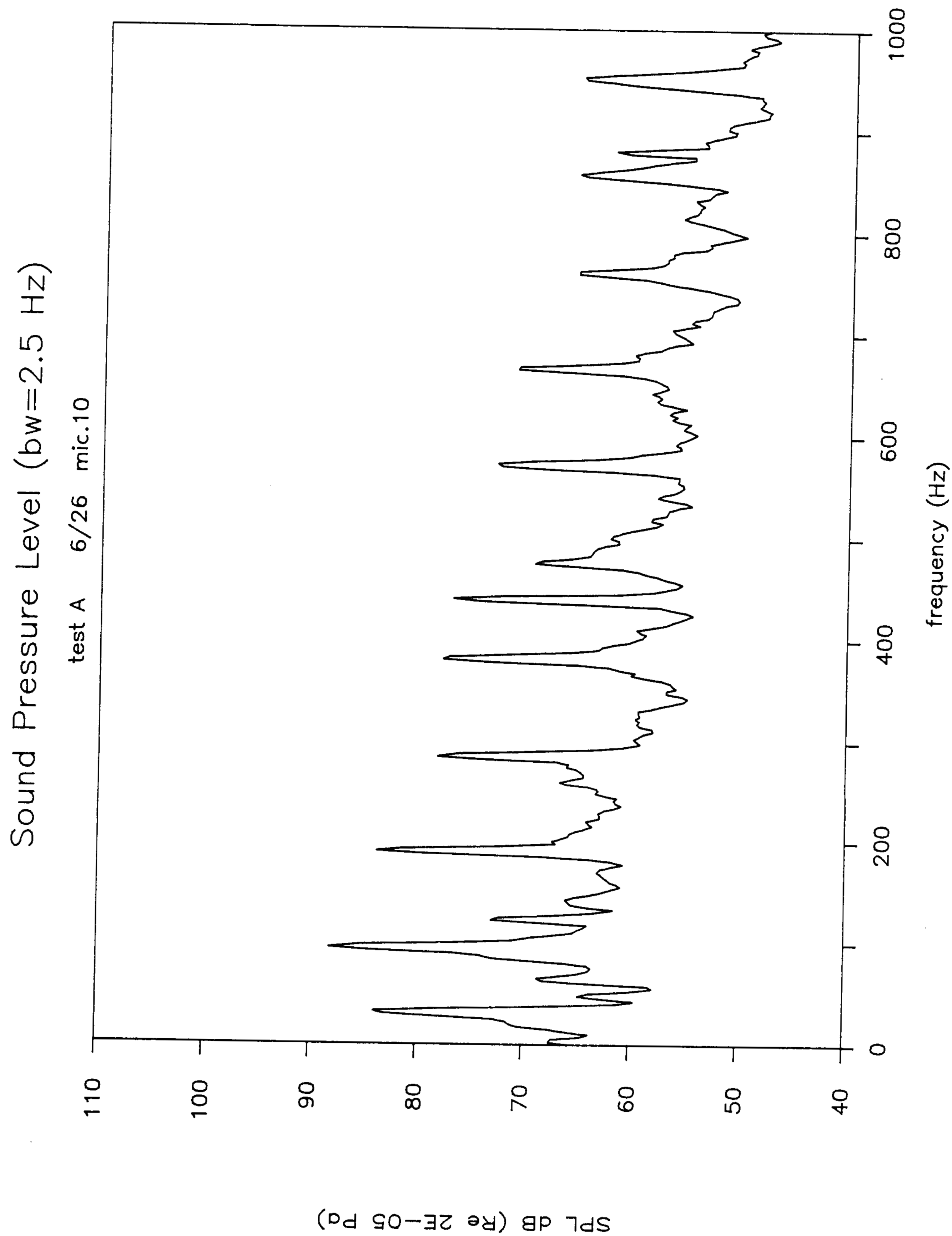

Sound Pressure Level (bw=2.5 Hz)
test A 6/26 mic.10
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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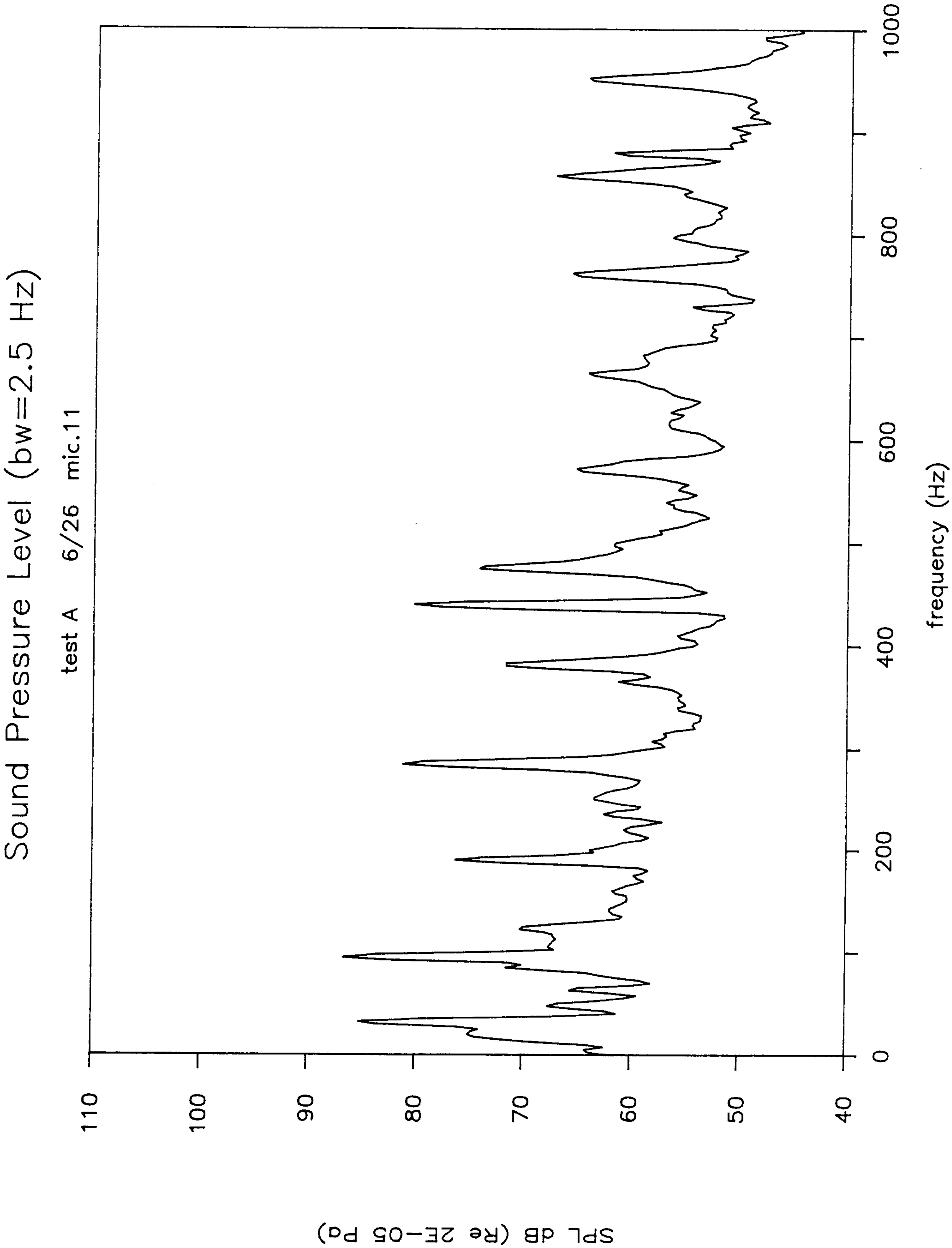
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frequency (Hz)
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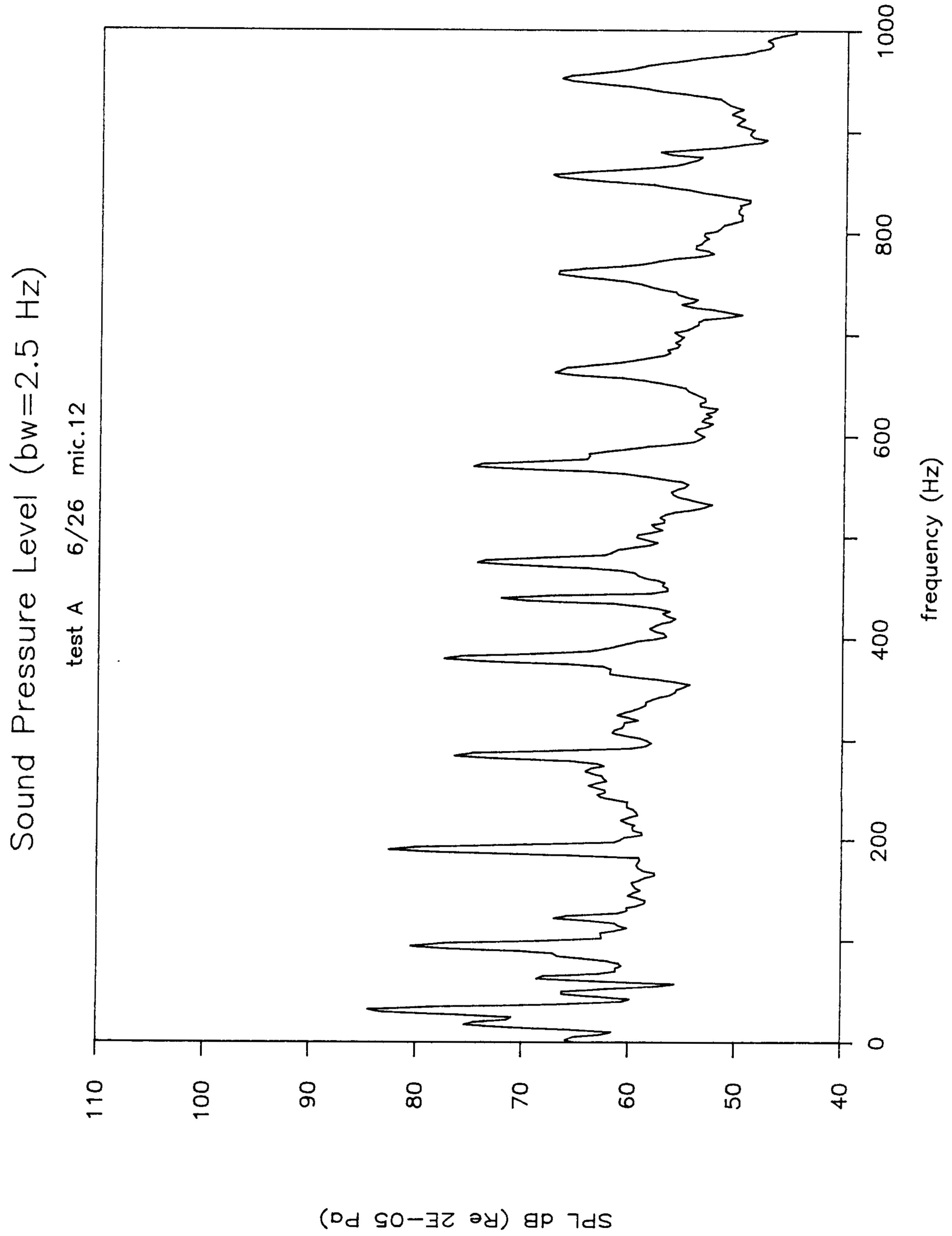
600
800
1000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SPL dB (Re 2E-05 Pa)
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60
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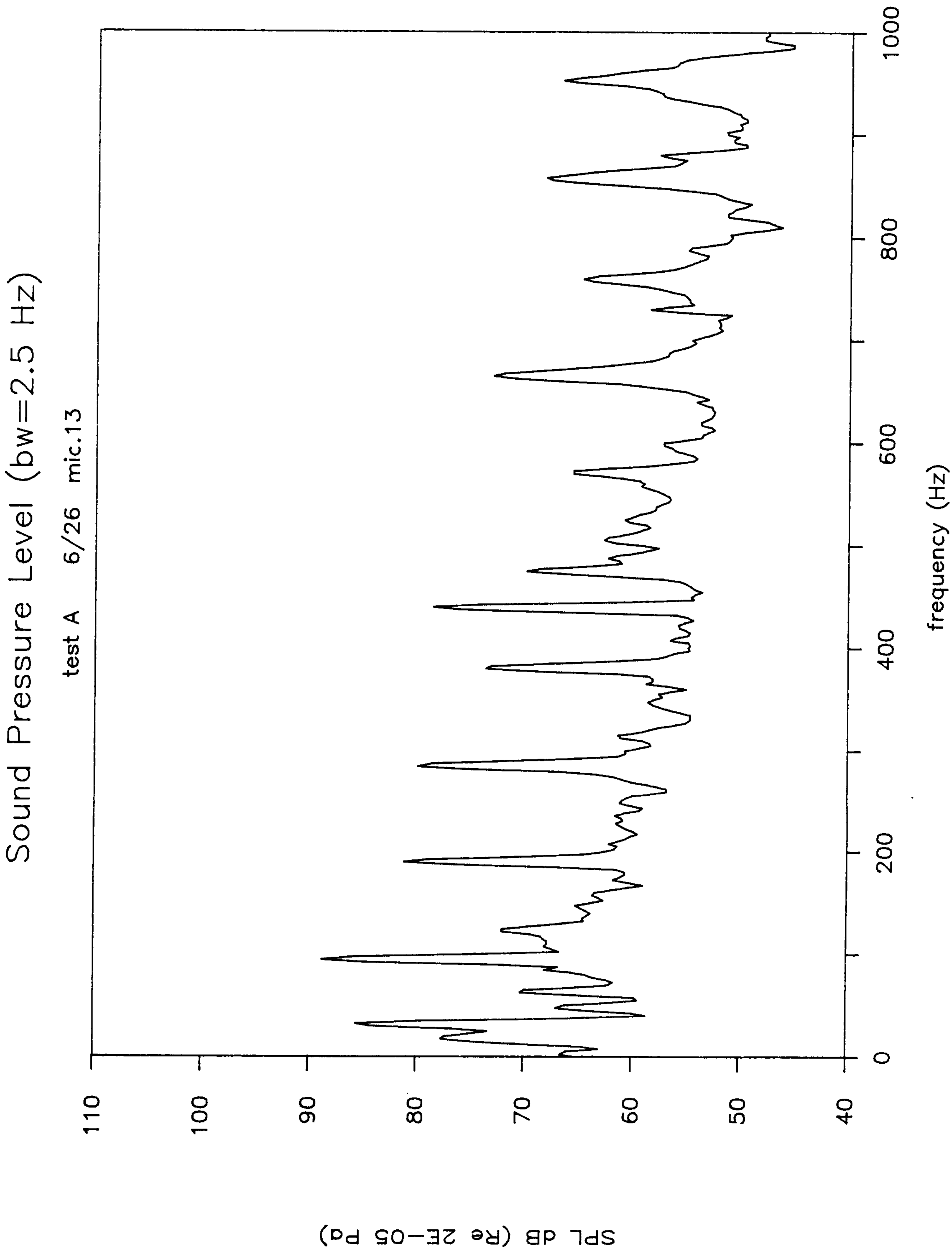
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
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SPL dB (Re 2E-05 Pa)
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80
70
60
50
40
frequency (Hz)
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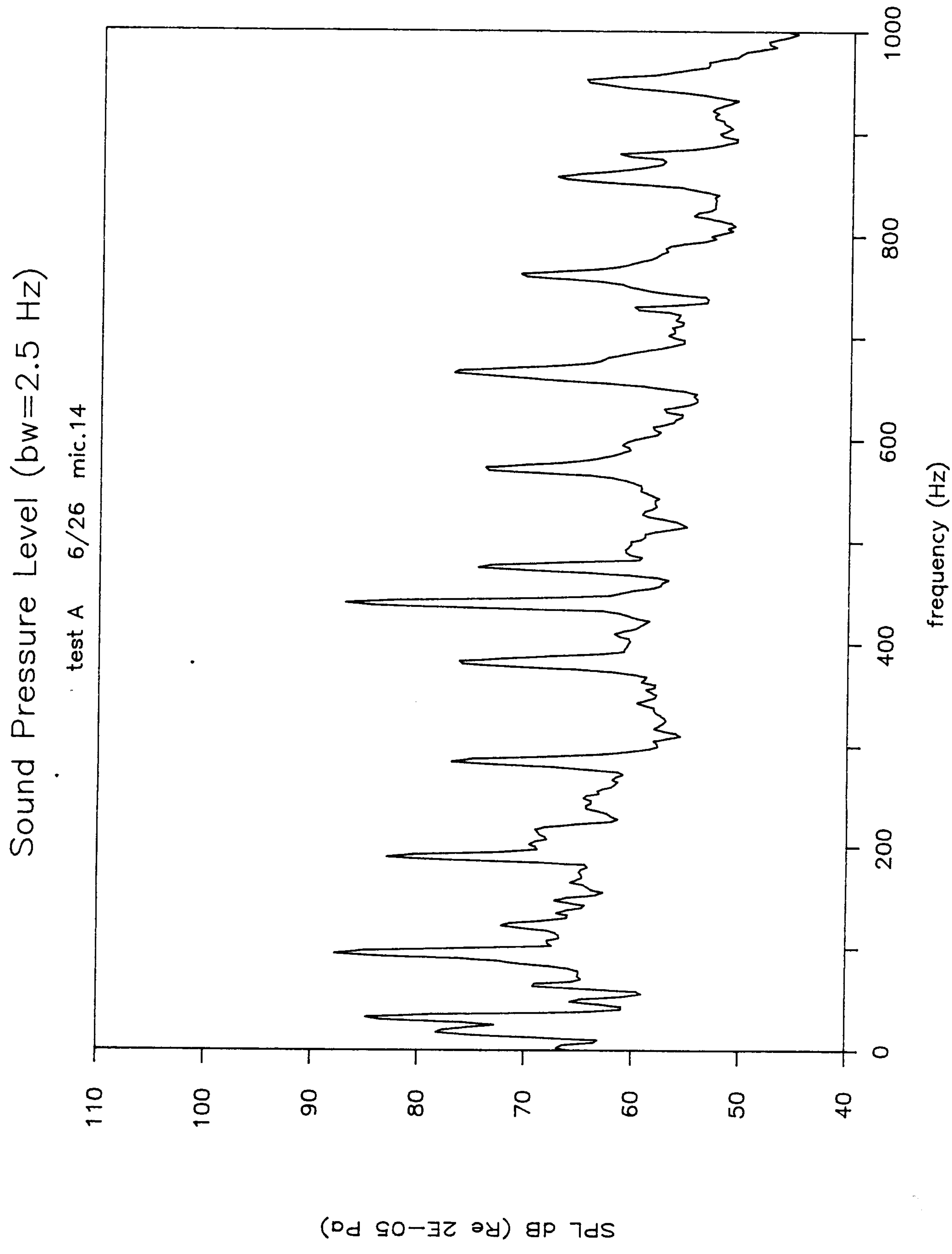
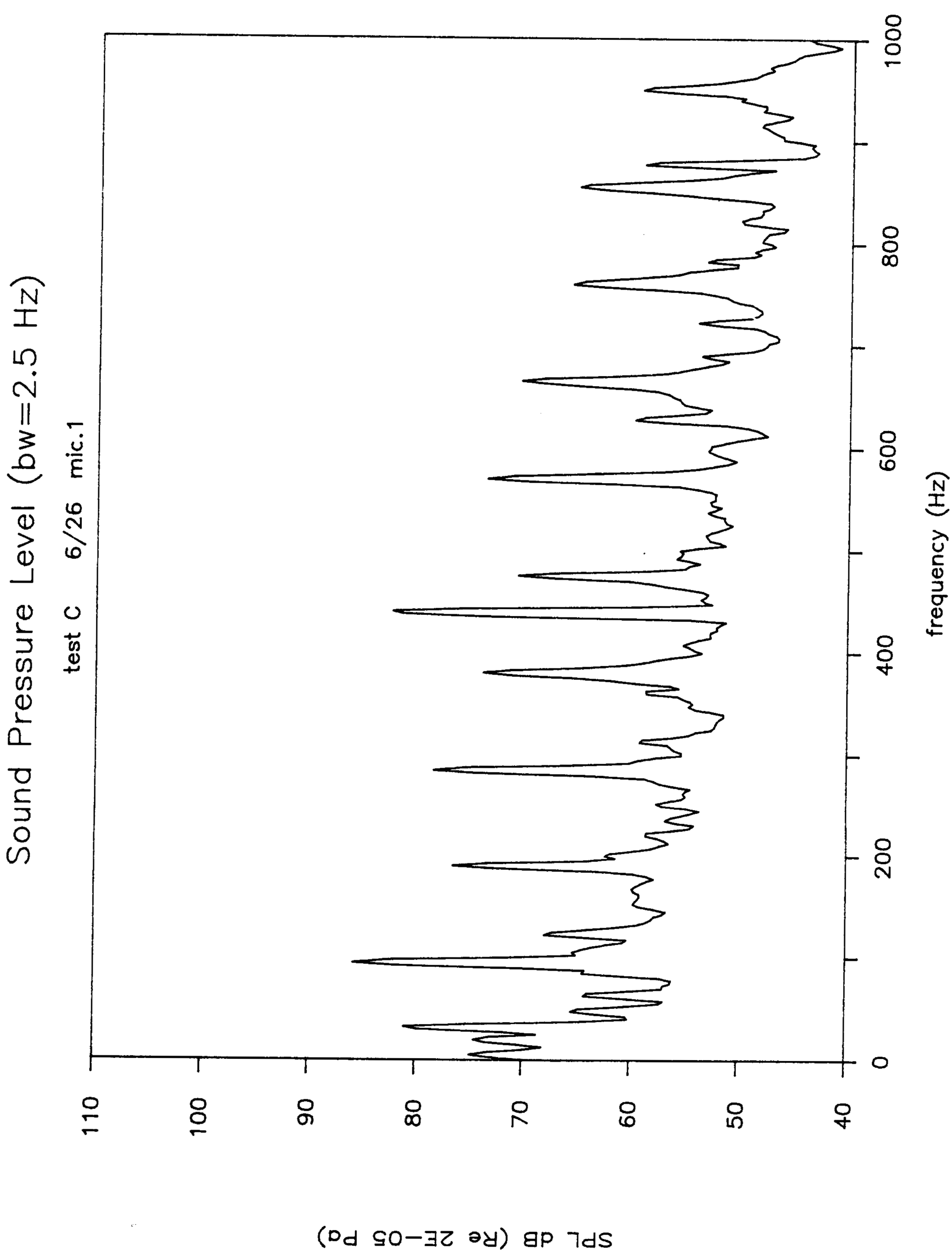
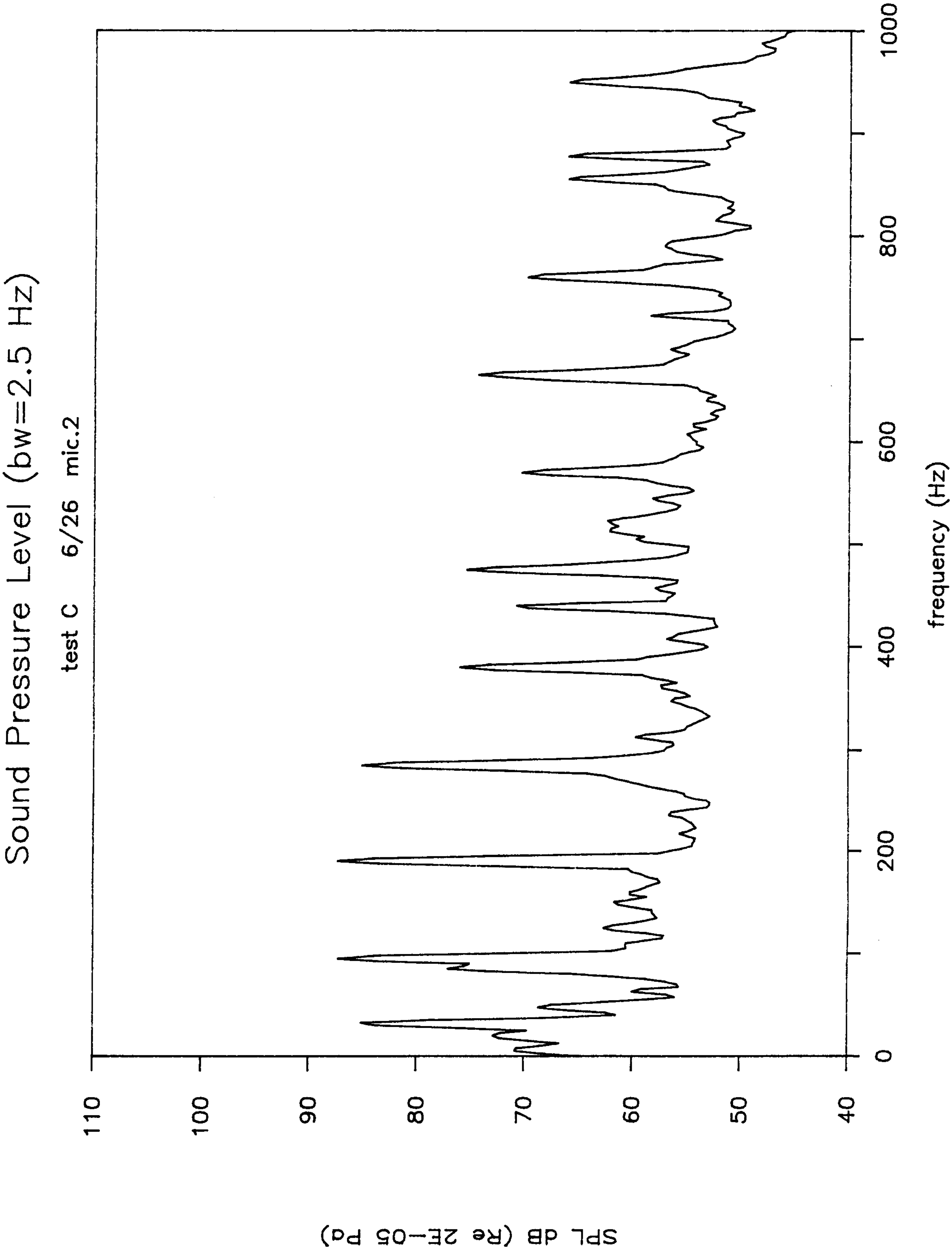
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 6/26 mic.14
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.1
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.2
SPL dB (Re 2E-05 Pa)
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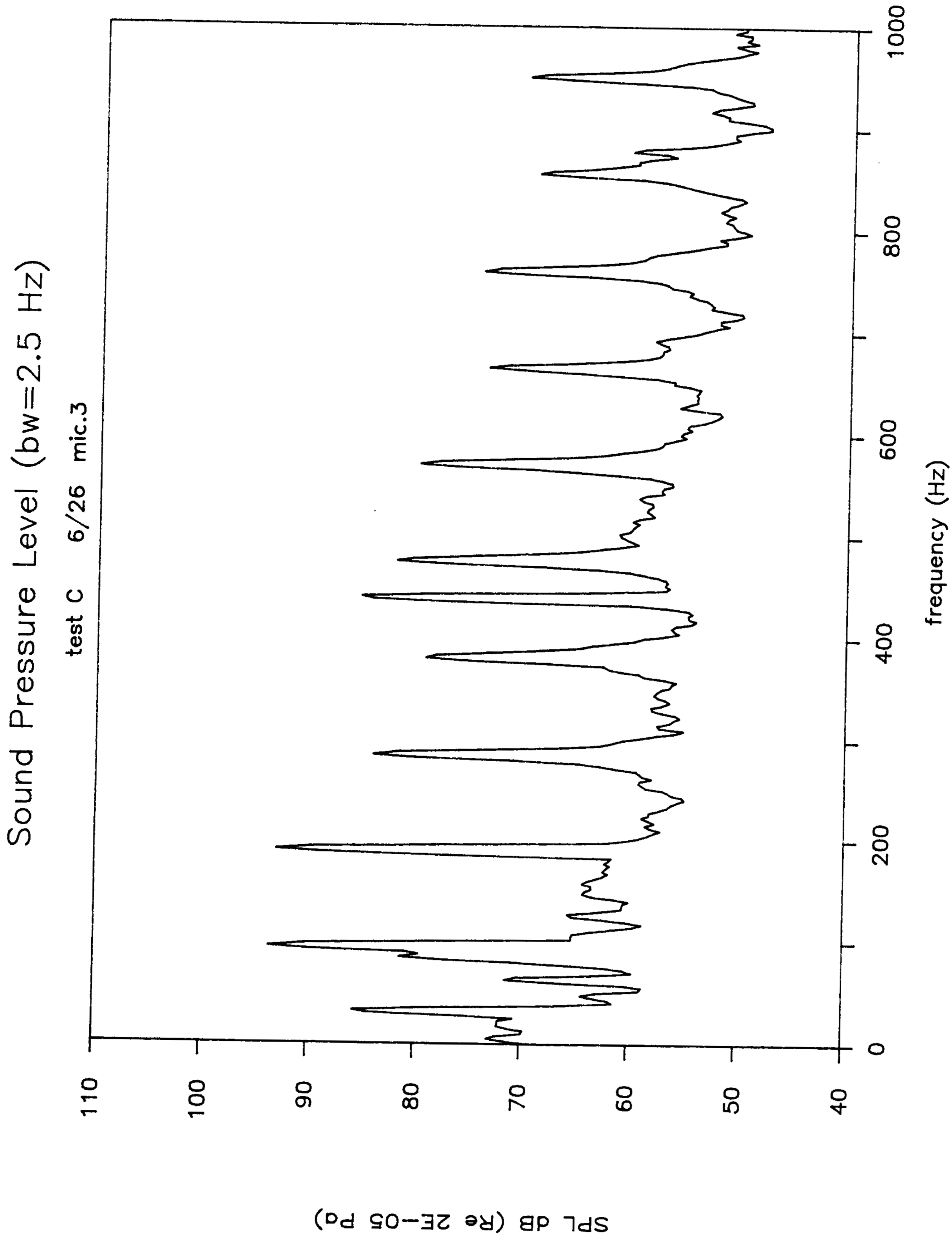
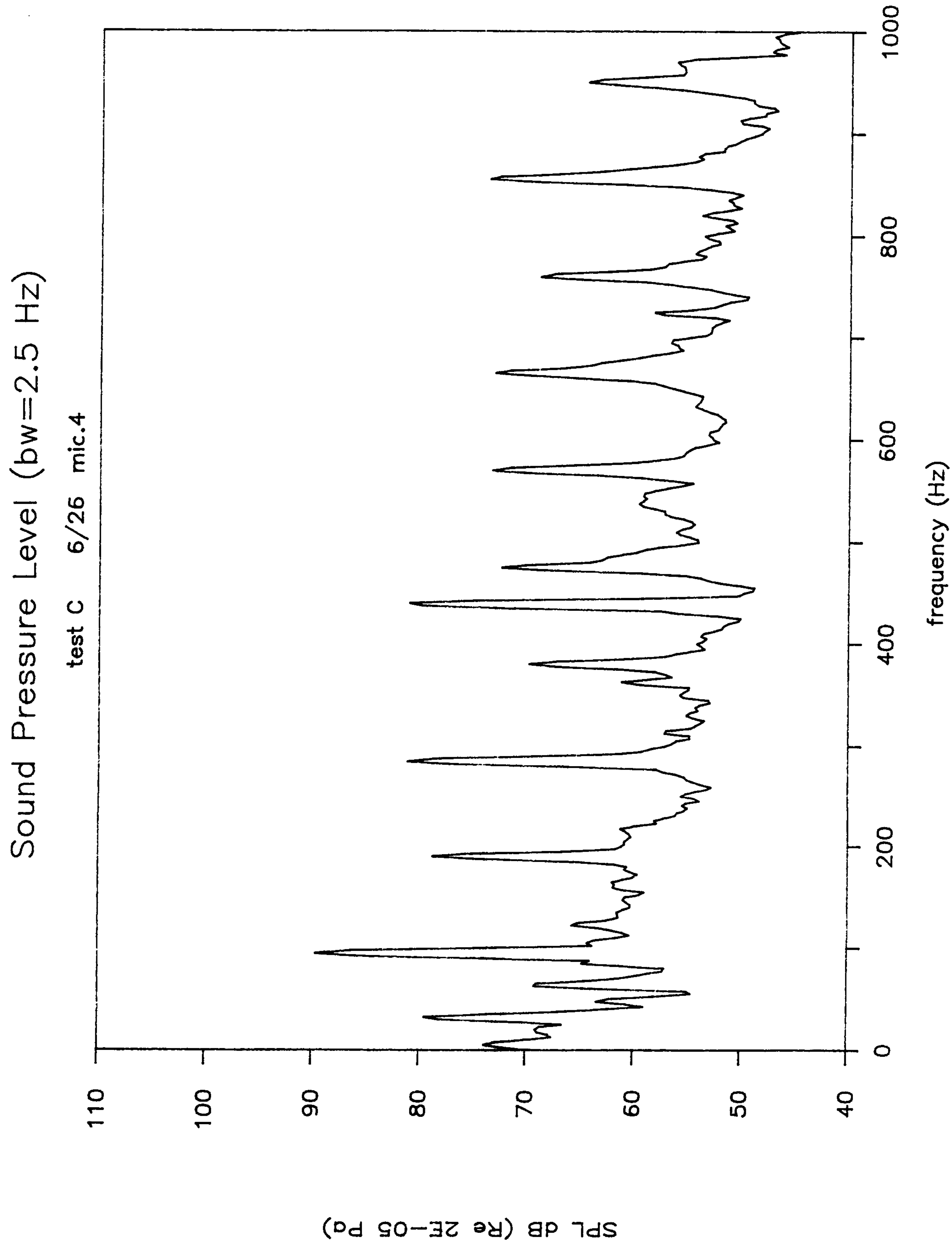
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000



Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.3
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.4
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
90
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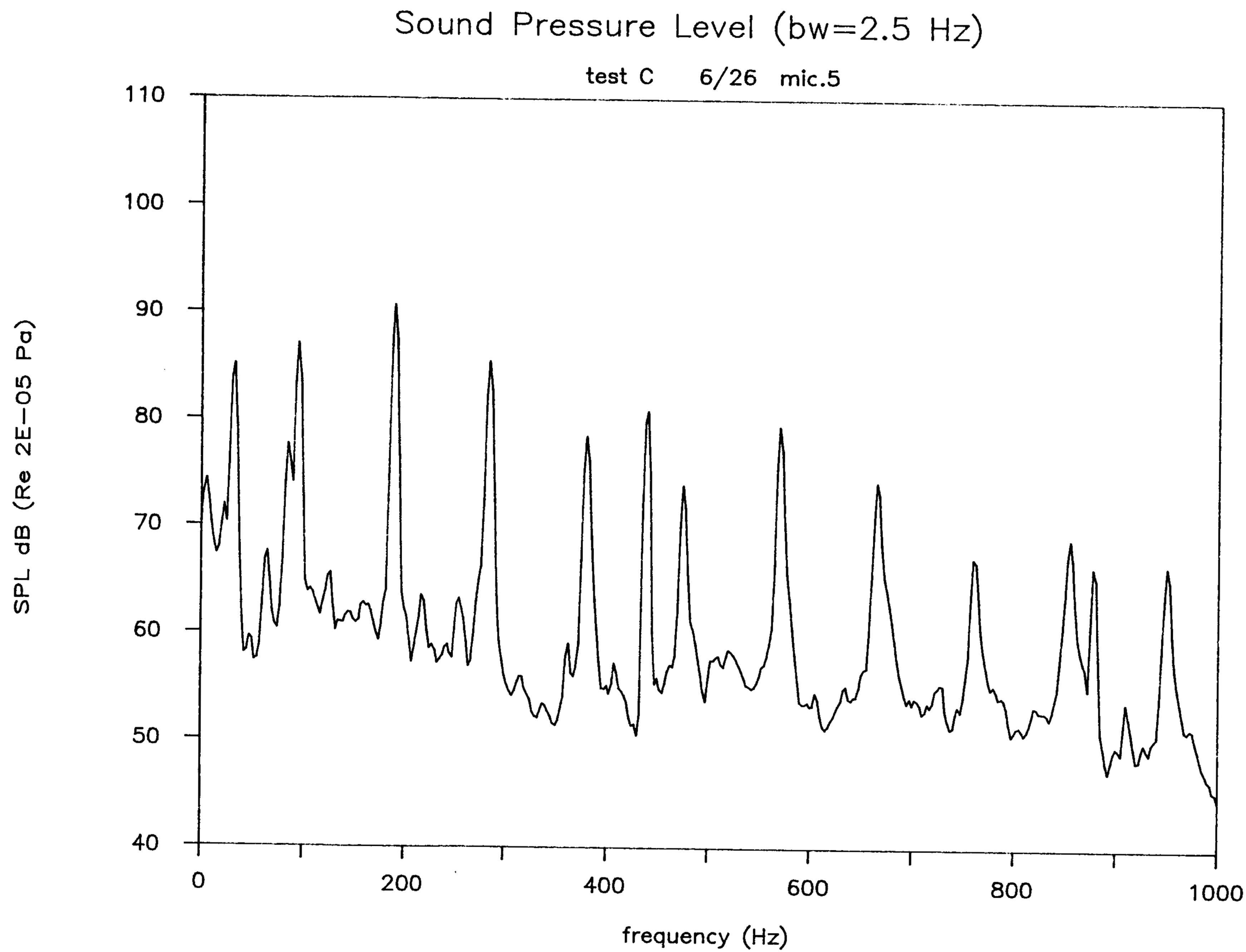
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.5
SPL dB (Re 2E-05 Pa)
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100
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80
70
60
50
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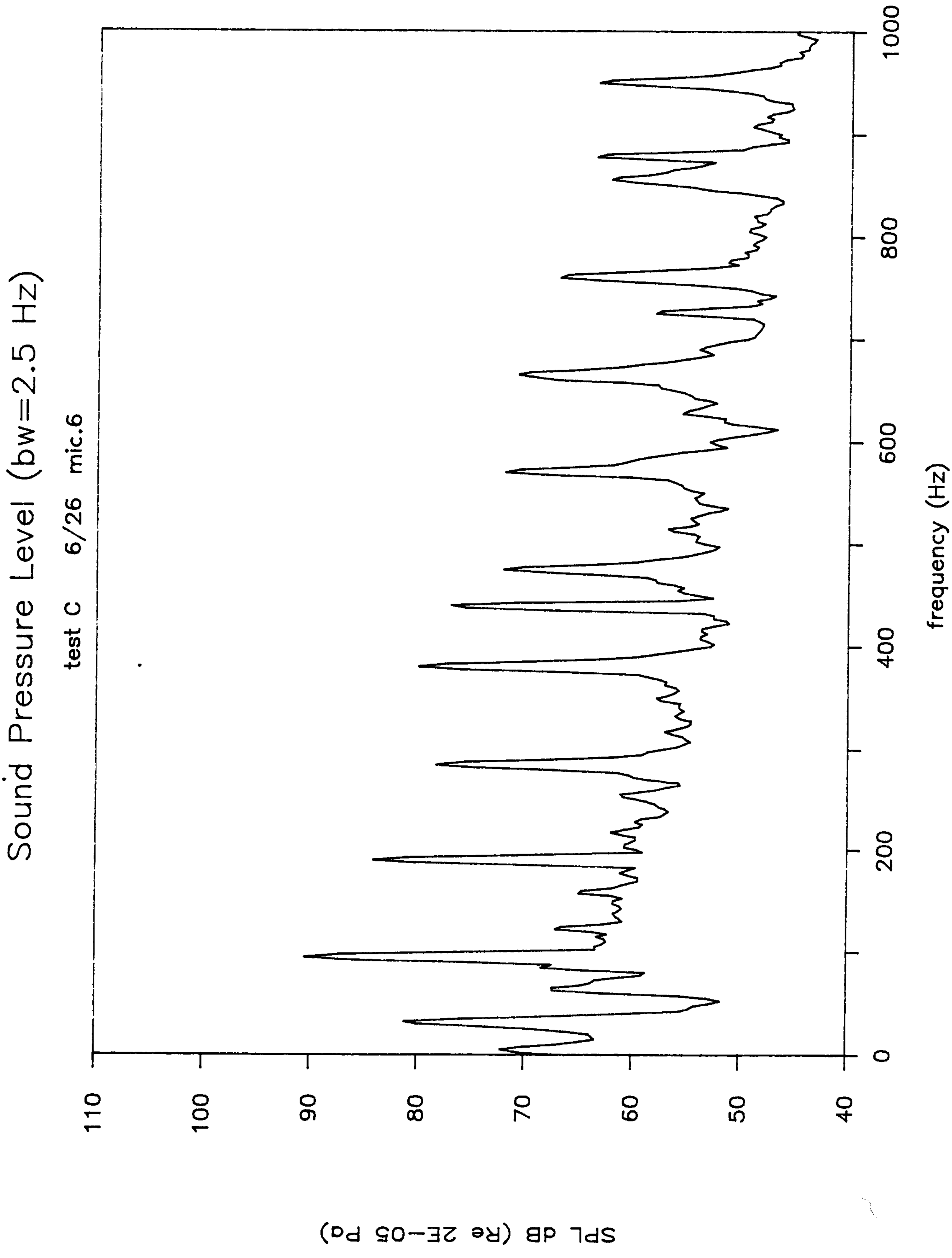
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.6
SPL dB (Re 2E-05 Pa)
110
100
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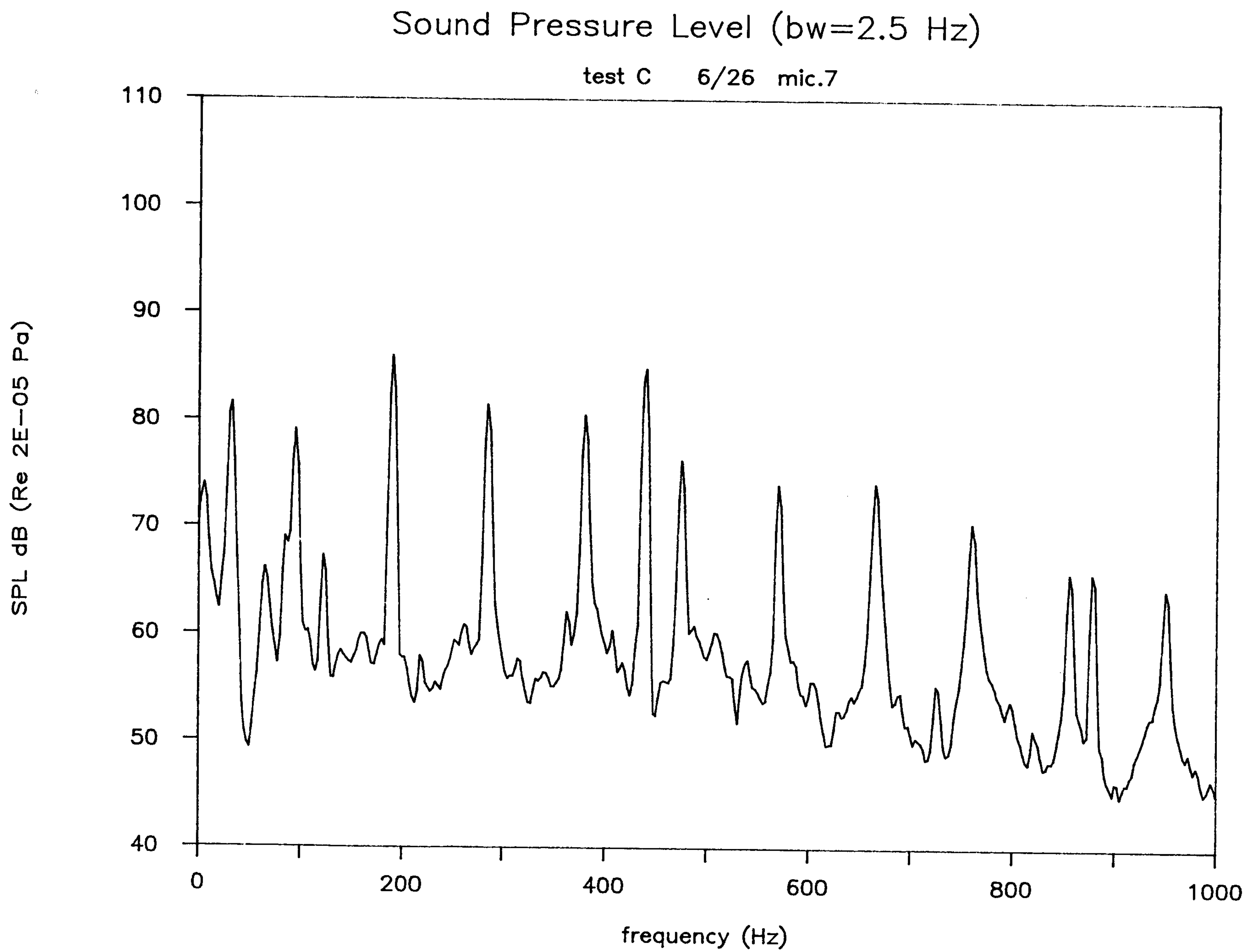
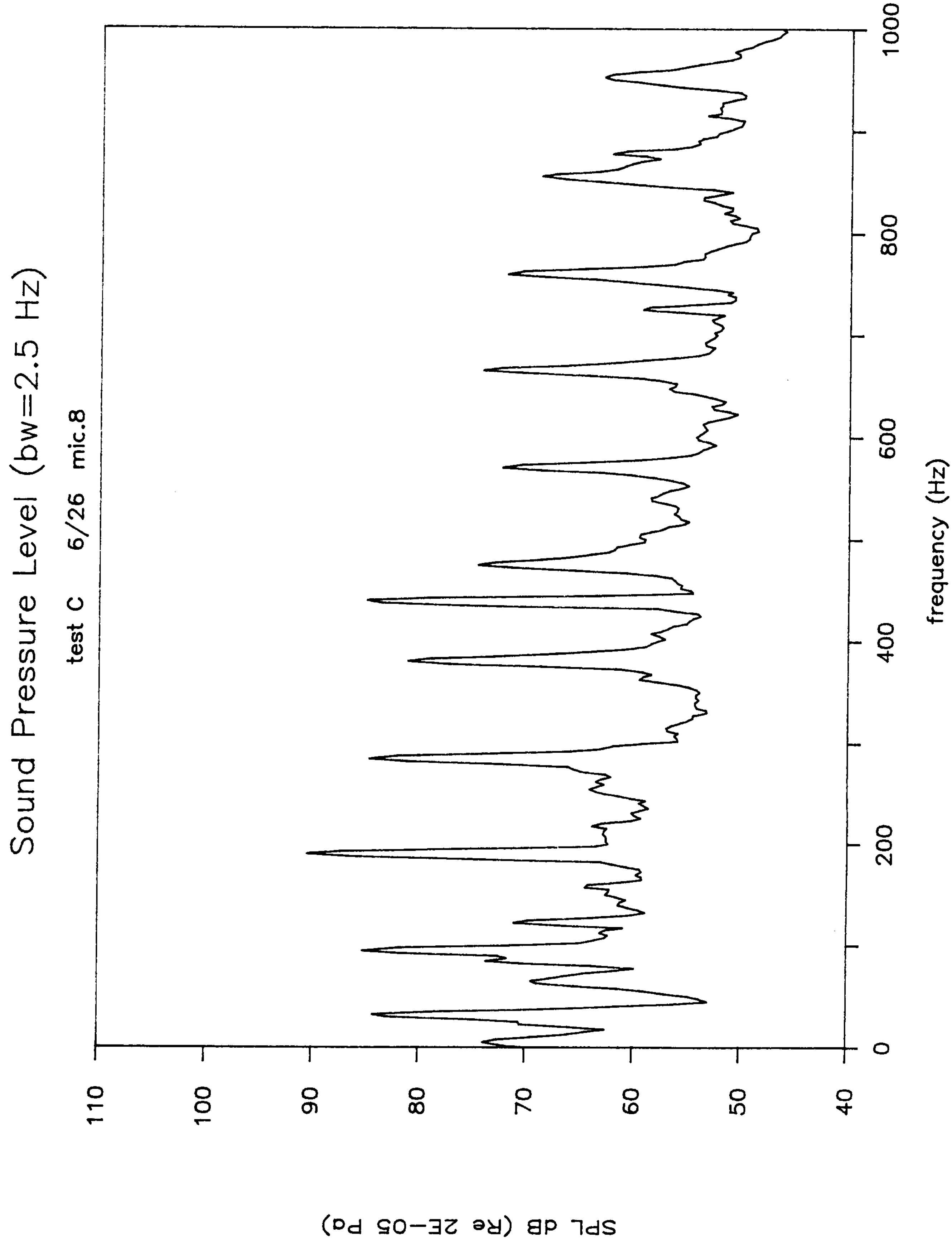
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.7
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.8
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
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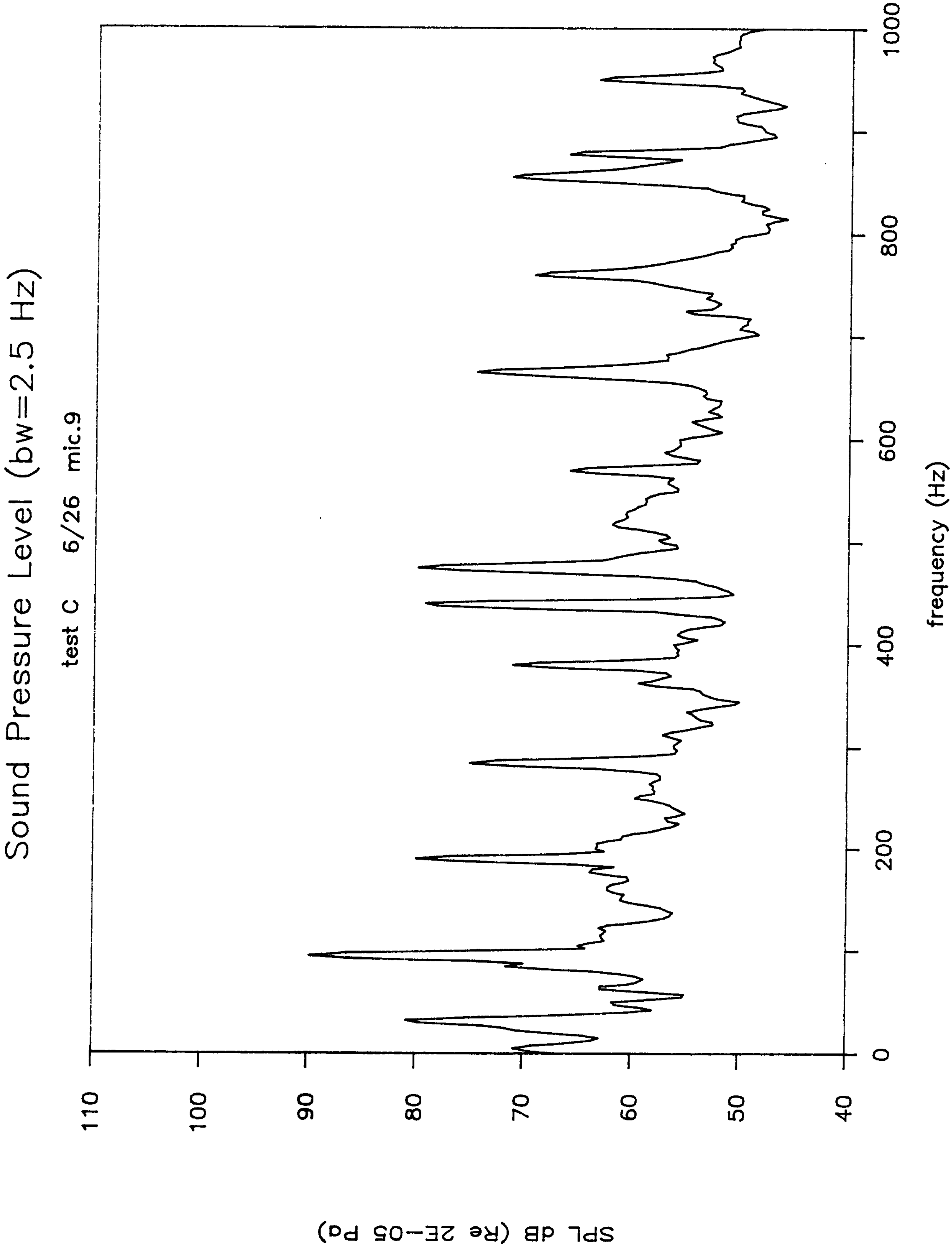
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.9
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
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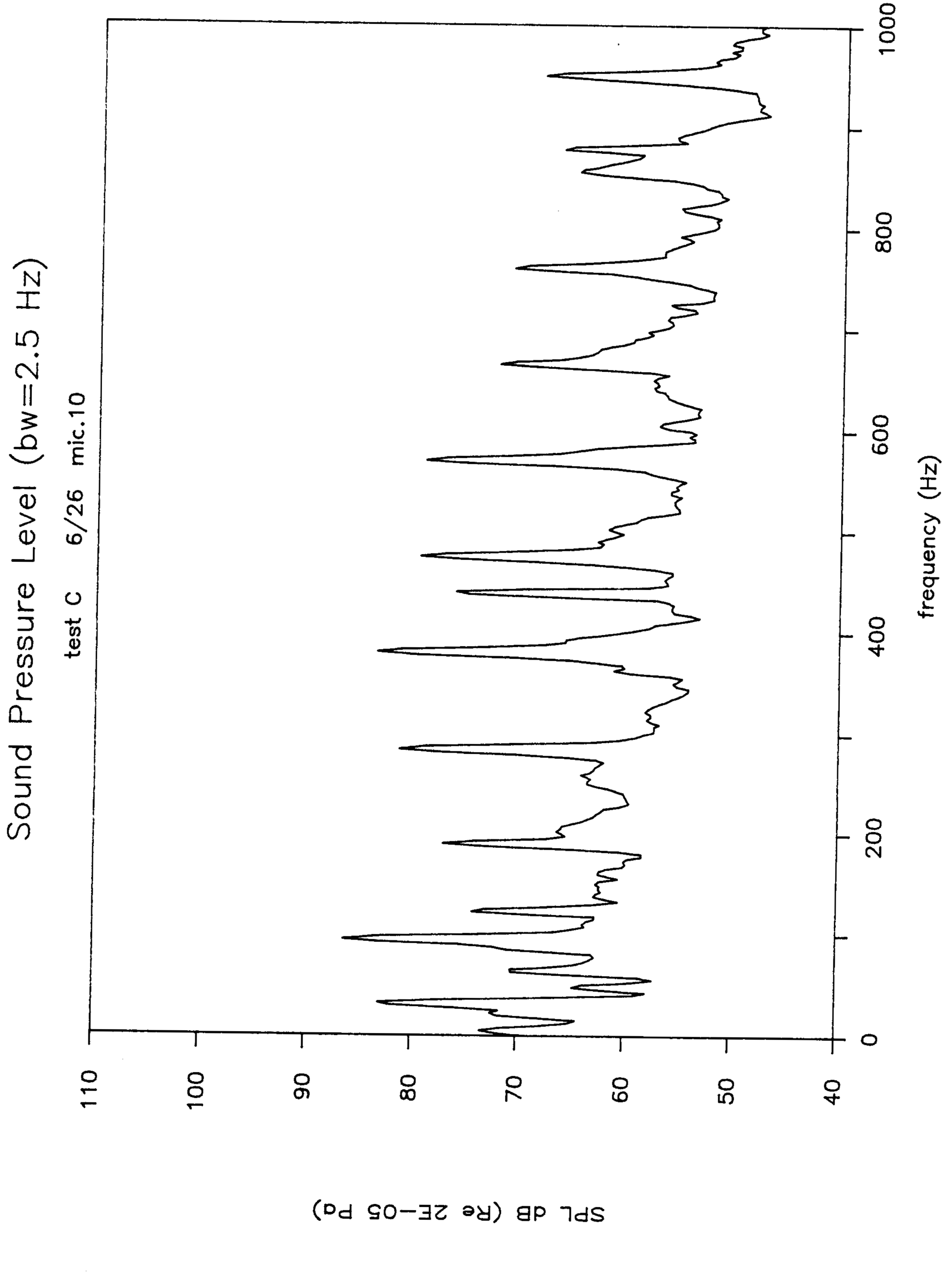
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.10
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
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80
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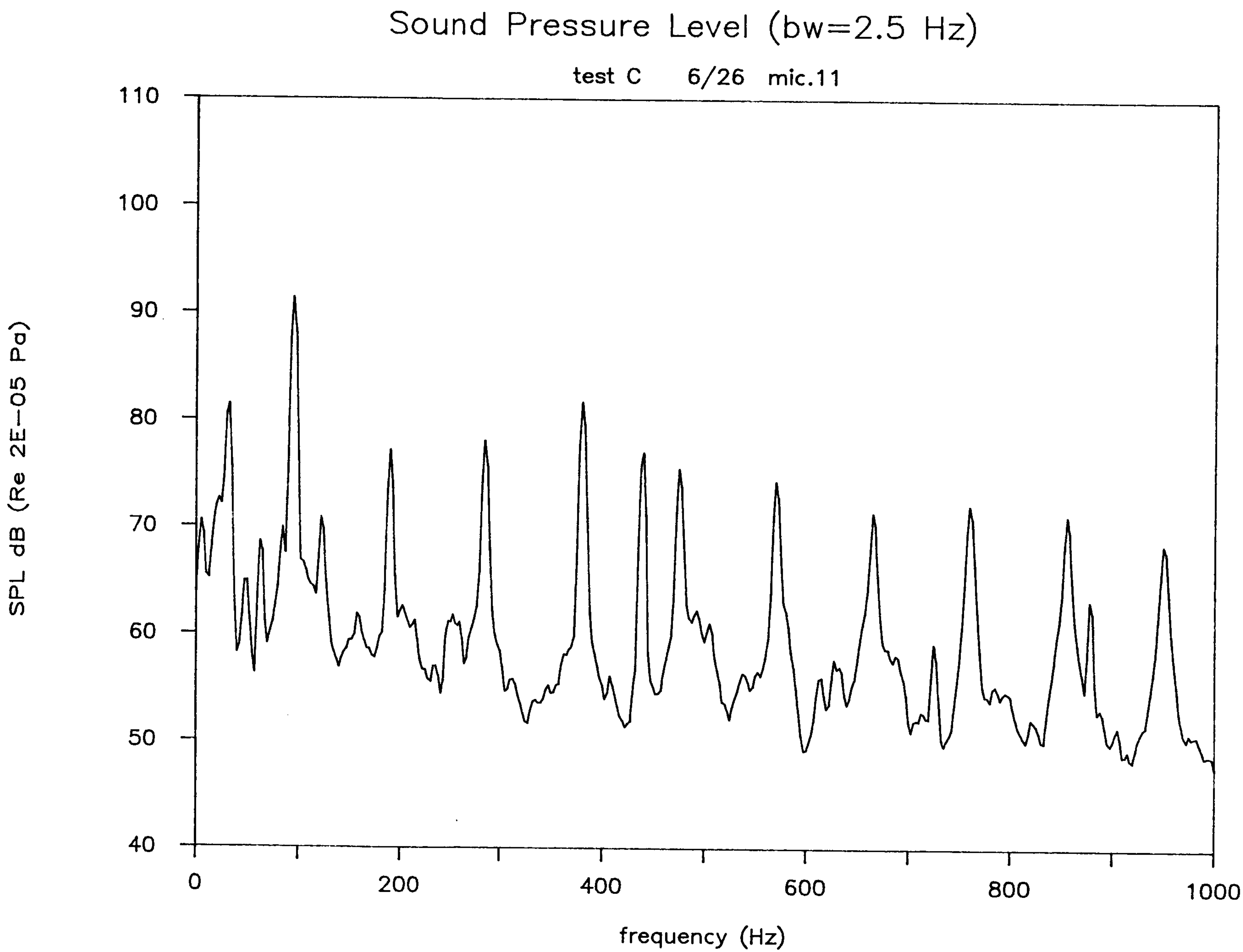
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.11
SPL dB (Re 2E-05 Pa)
110
100
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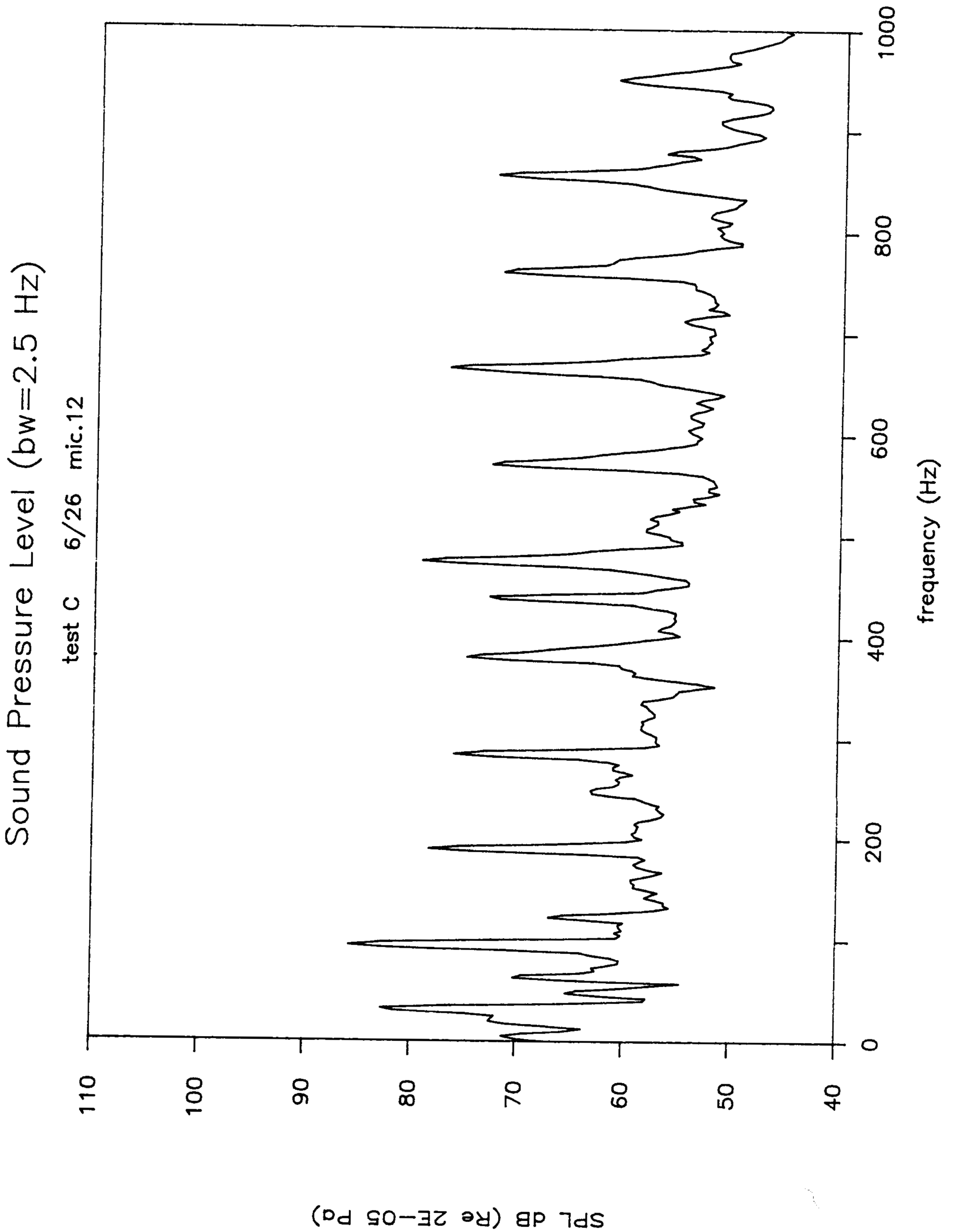
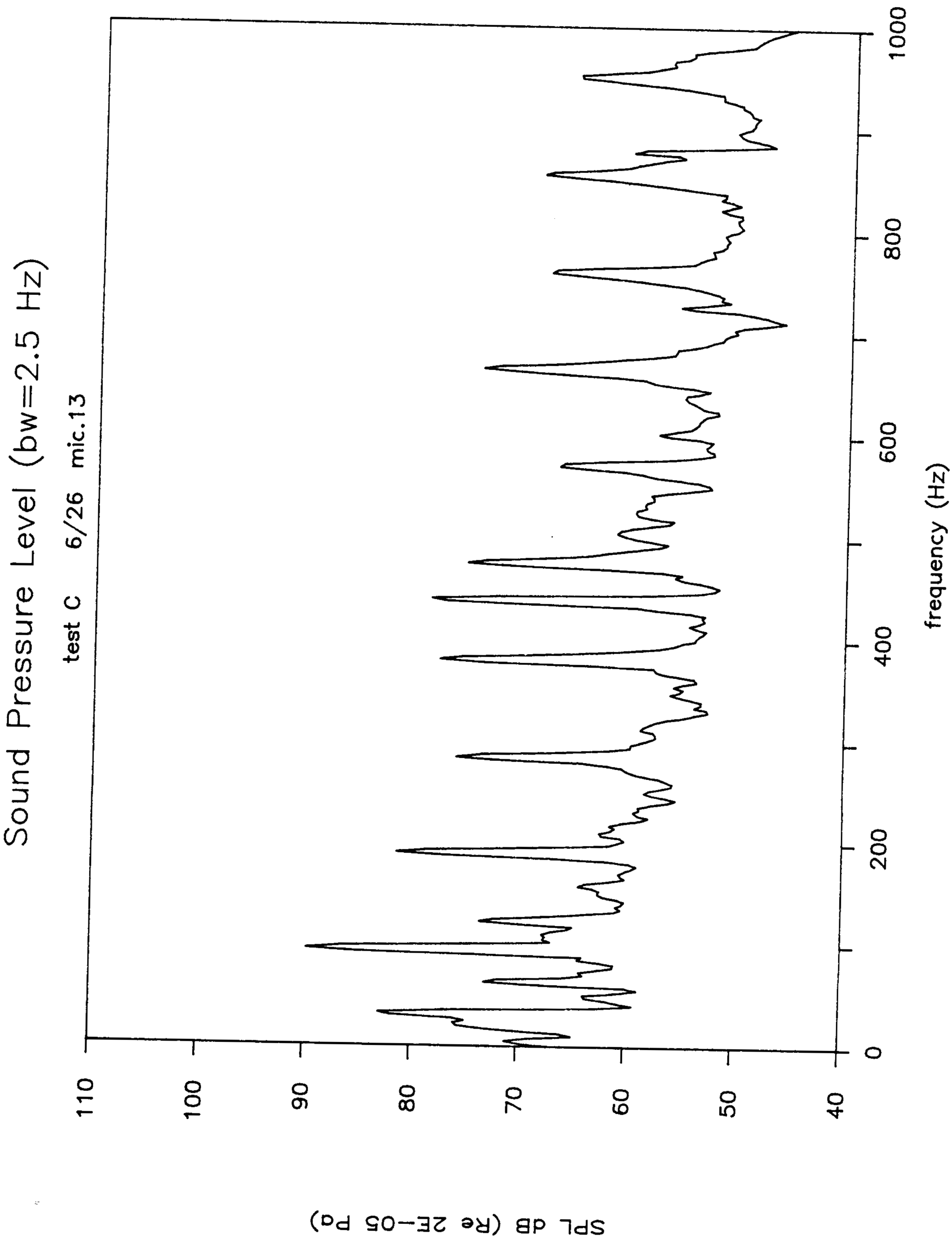
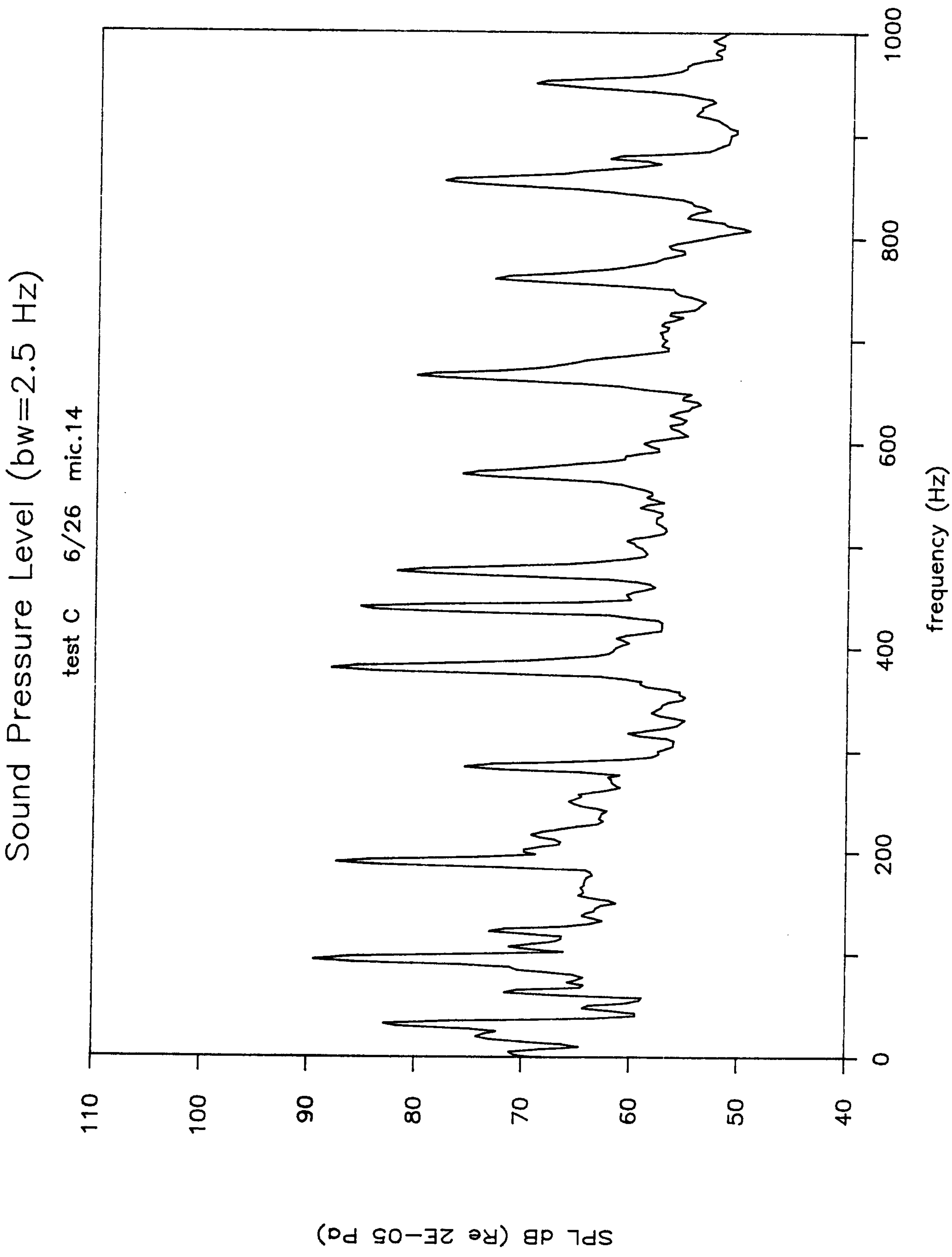
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.12
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.13
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test C 6/26 mic.14
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
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80
70
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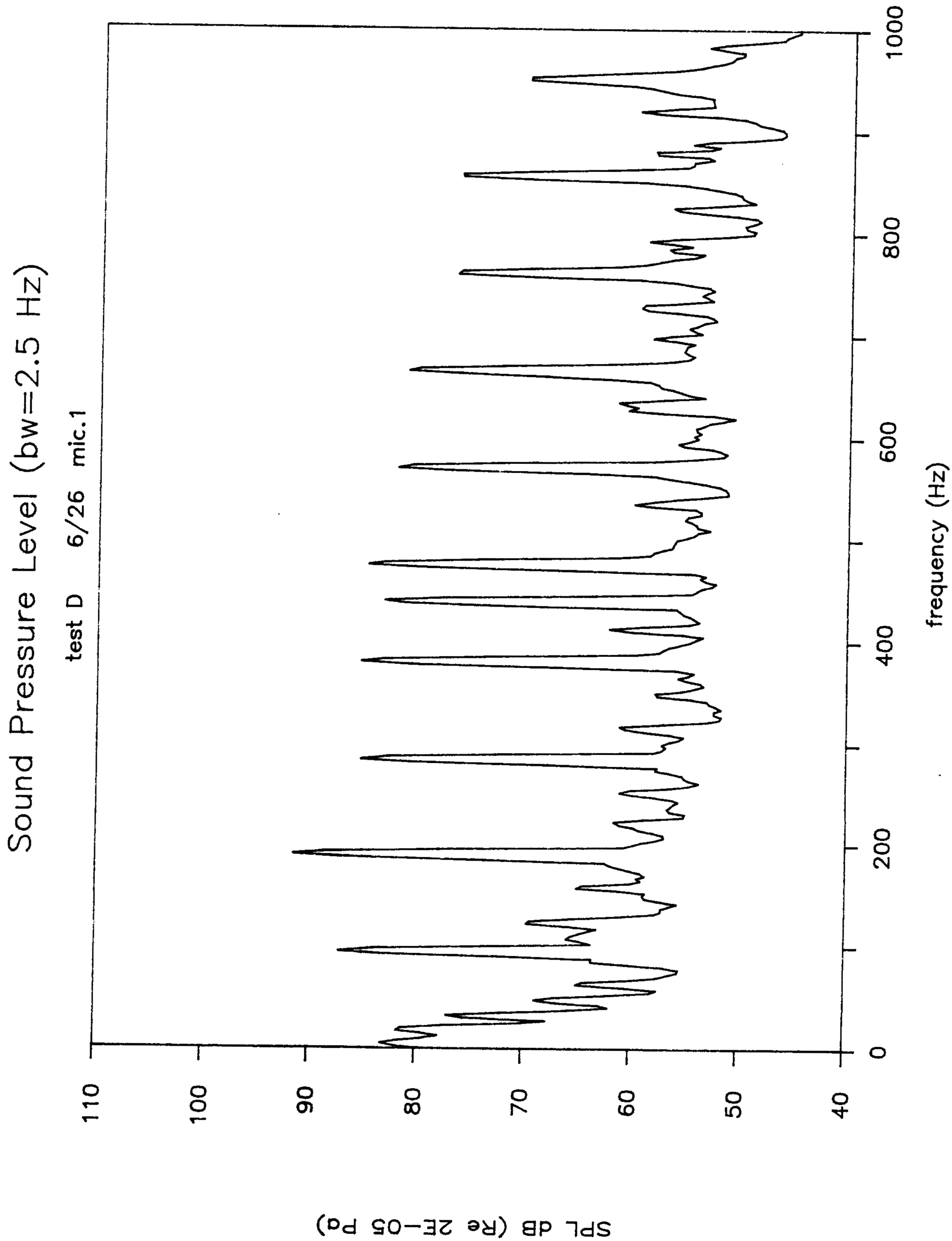
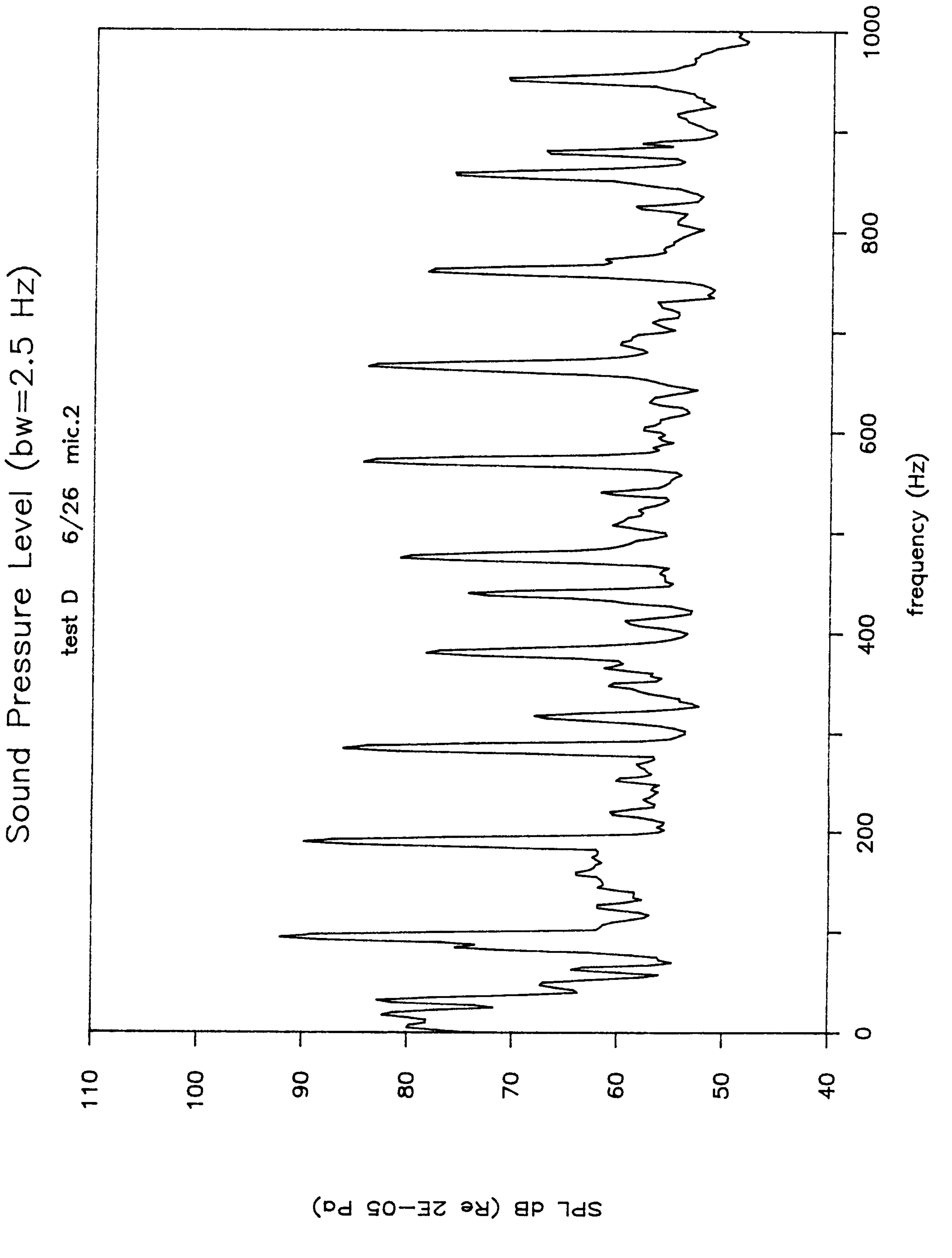
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.1
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.2
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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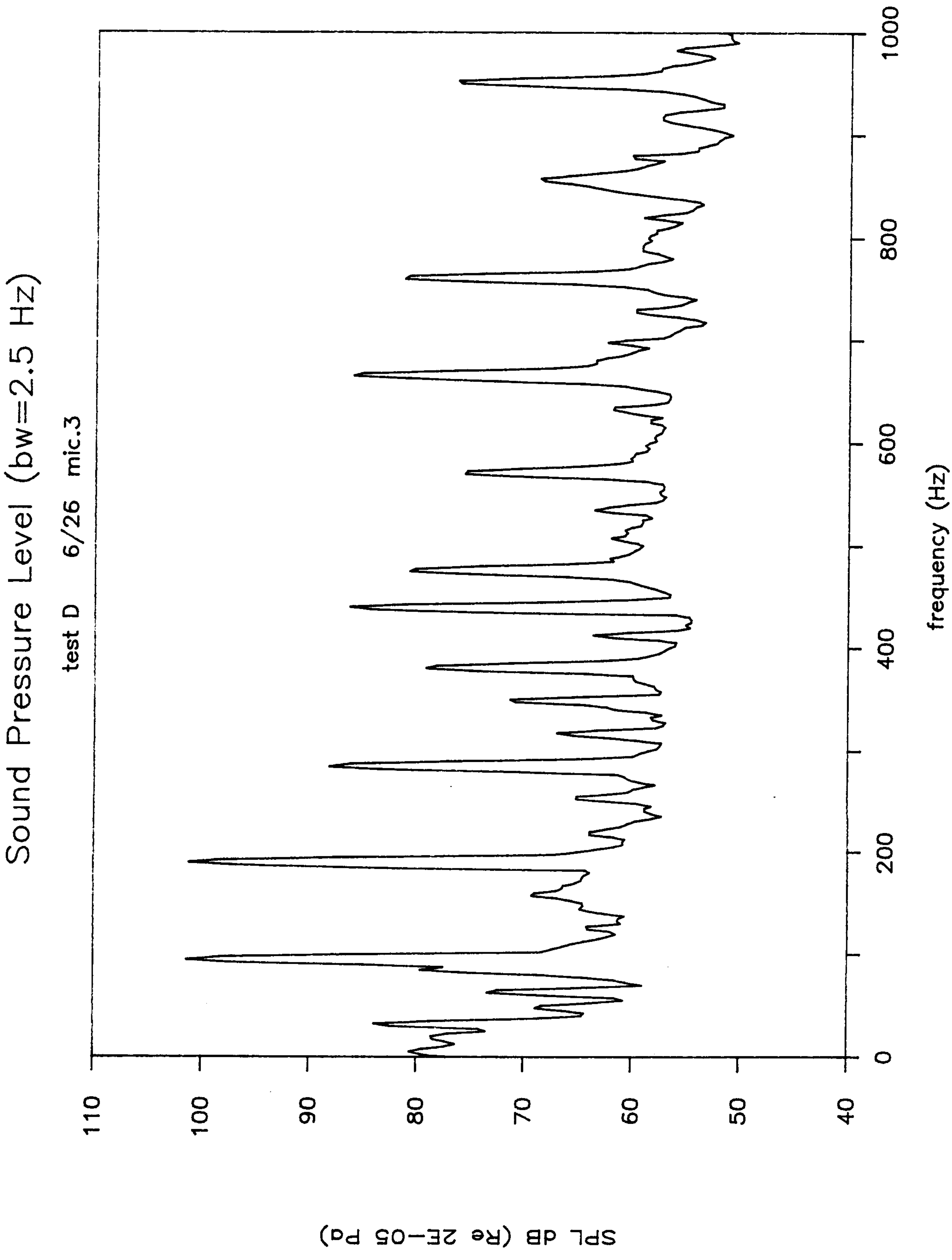
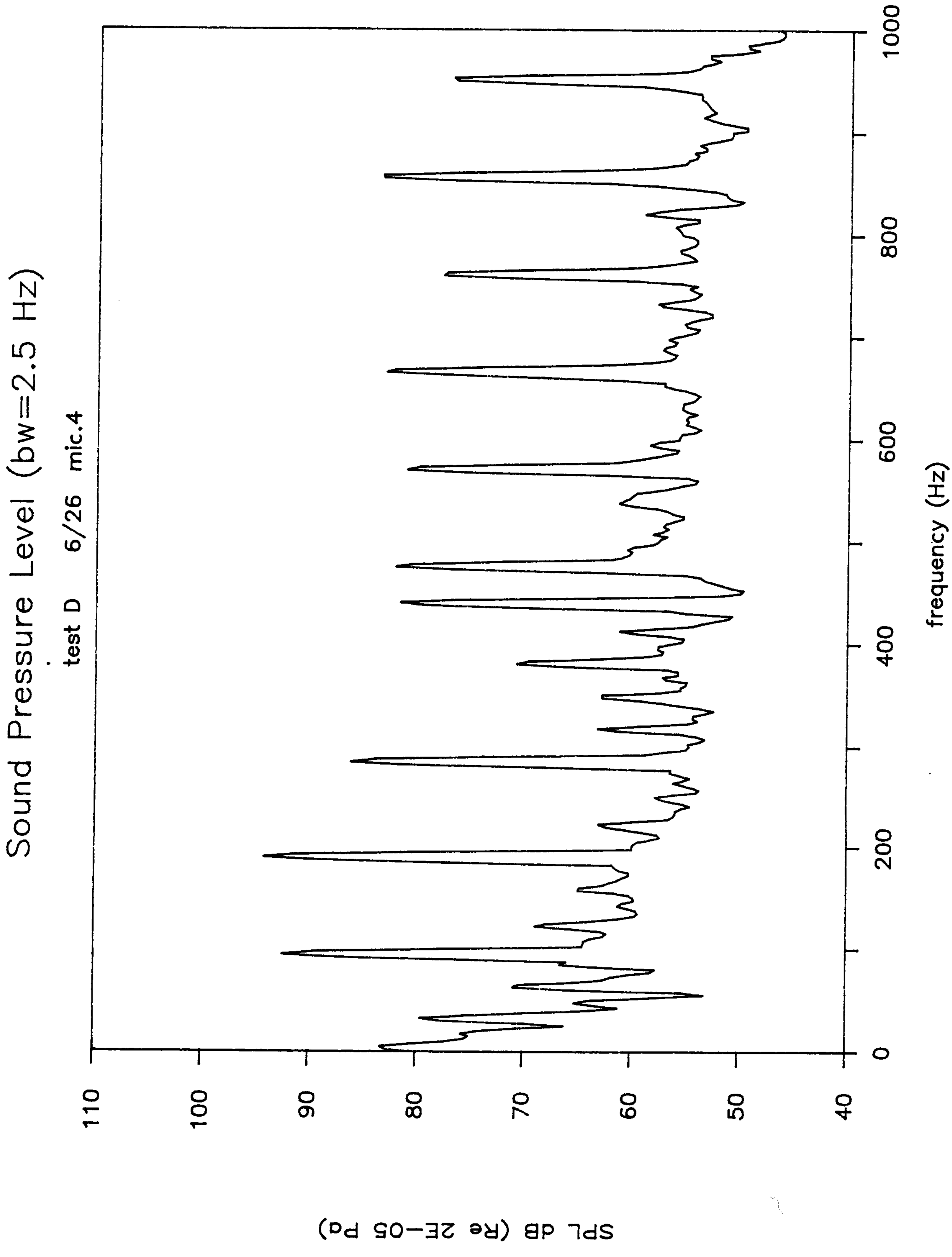
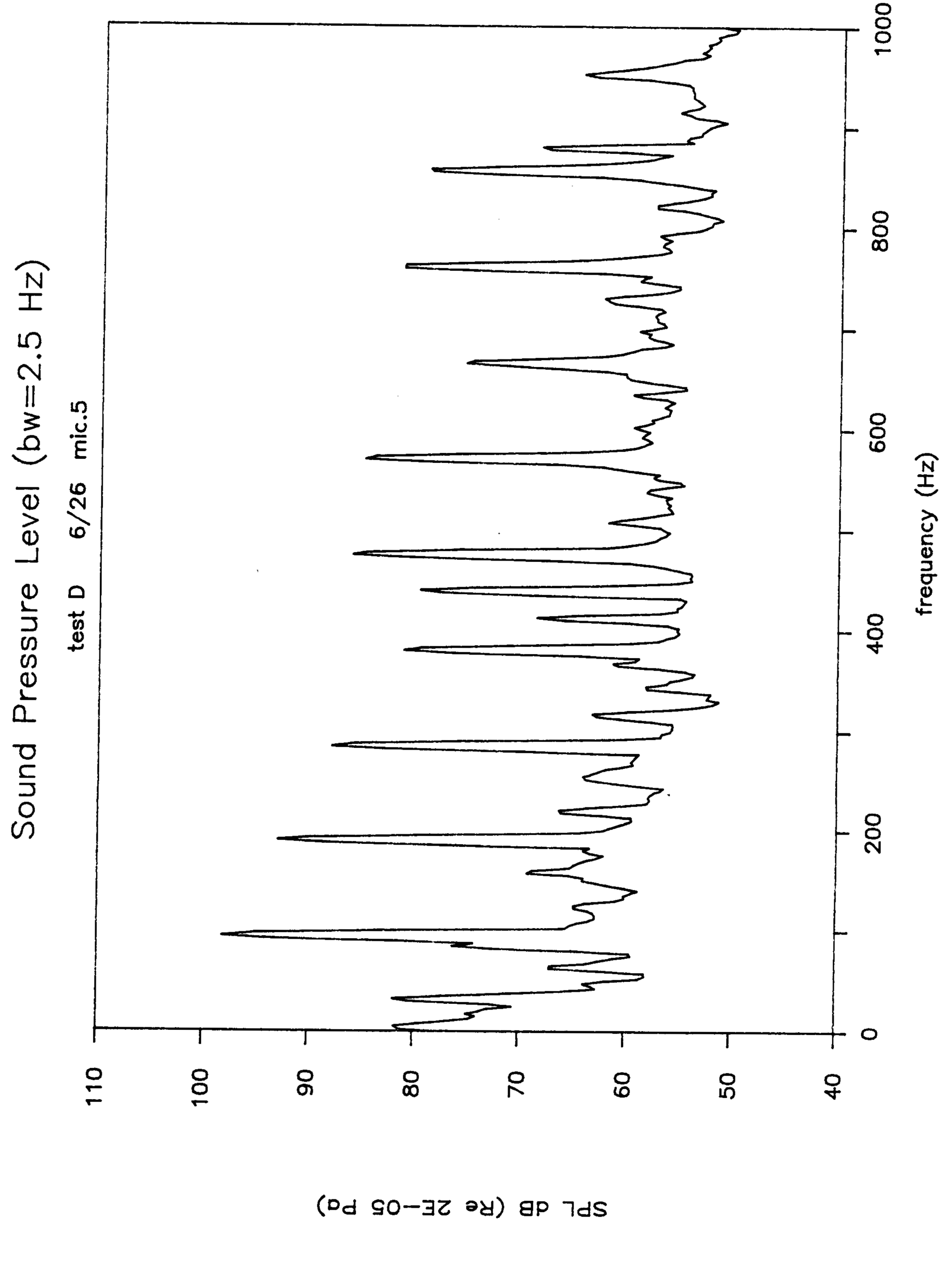
100
90
80
70
60
50
40
0
200
400
600
800
1000



Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.3
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)



Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.4
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.5
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
90
80
70
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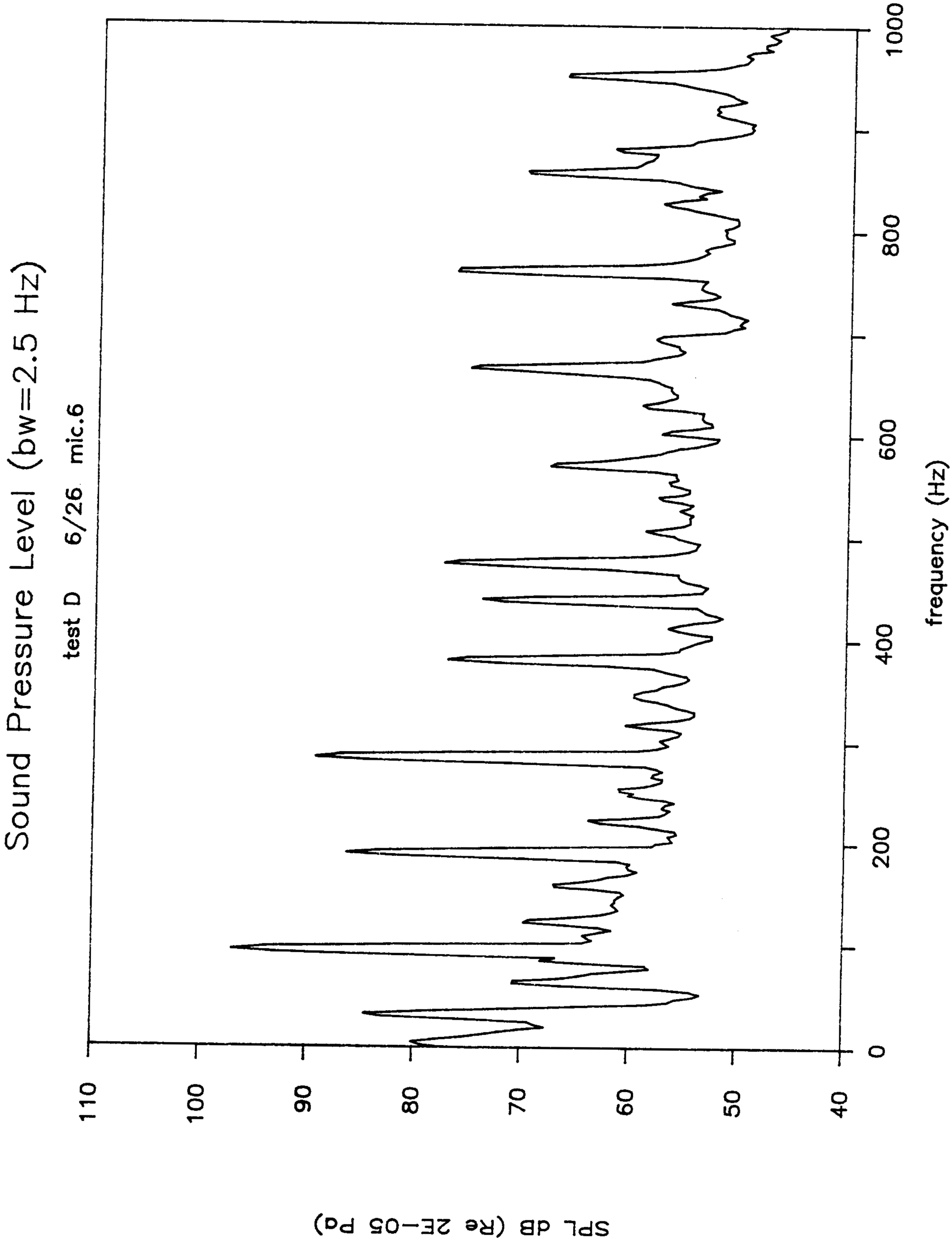
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.6
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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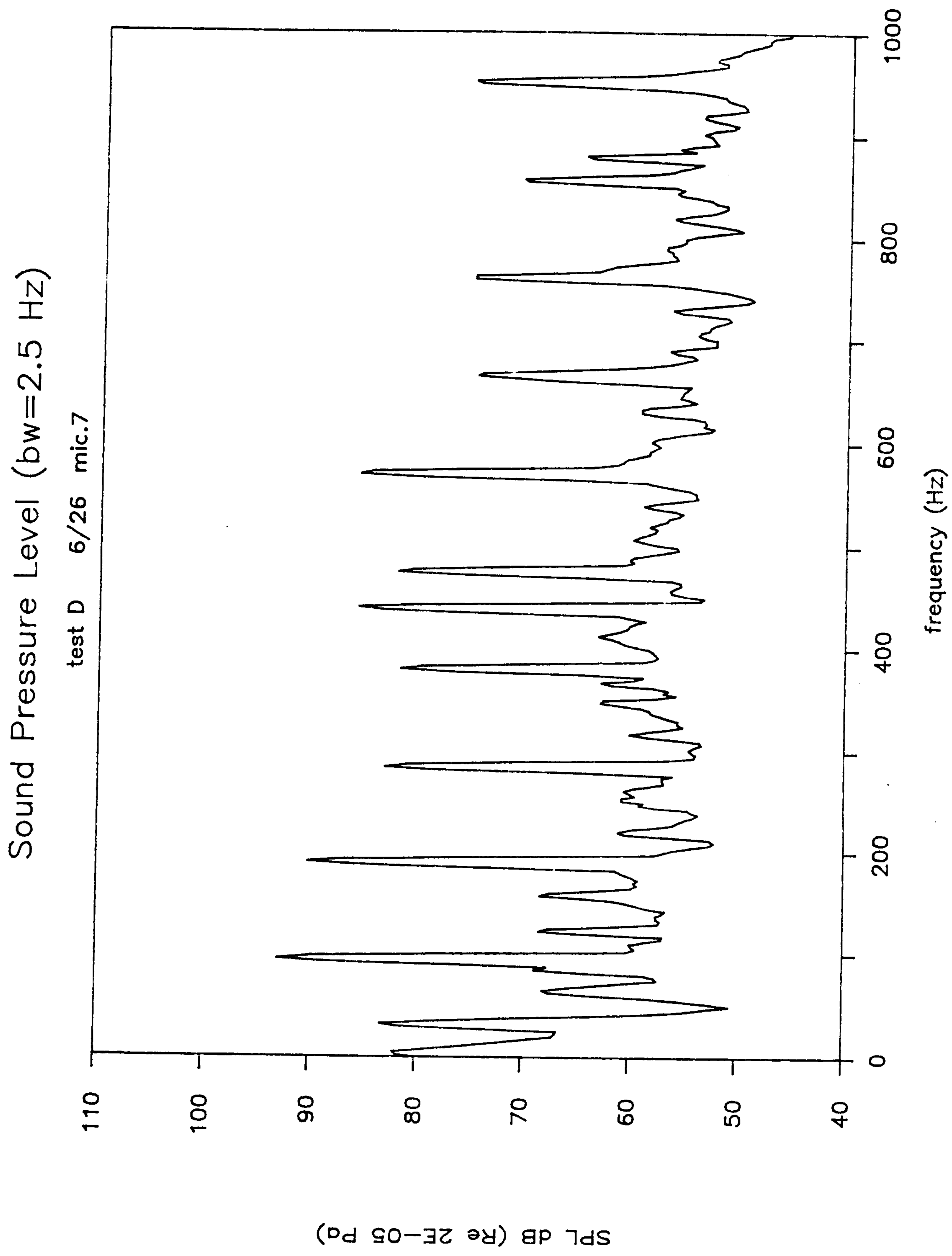
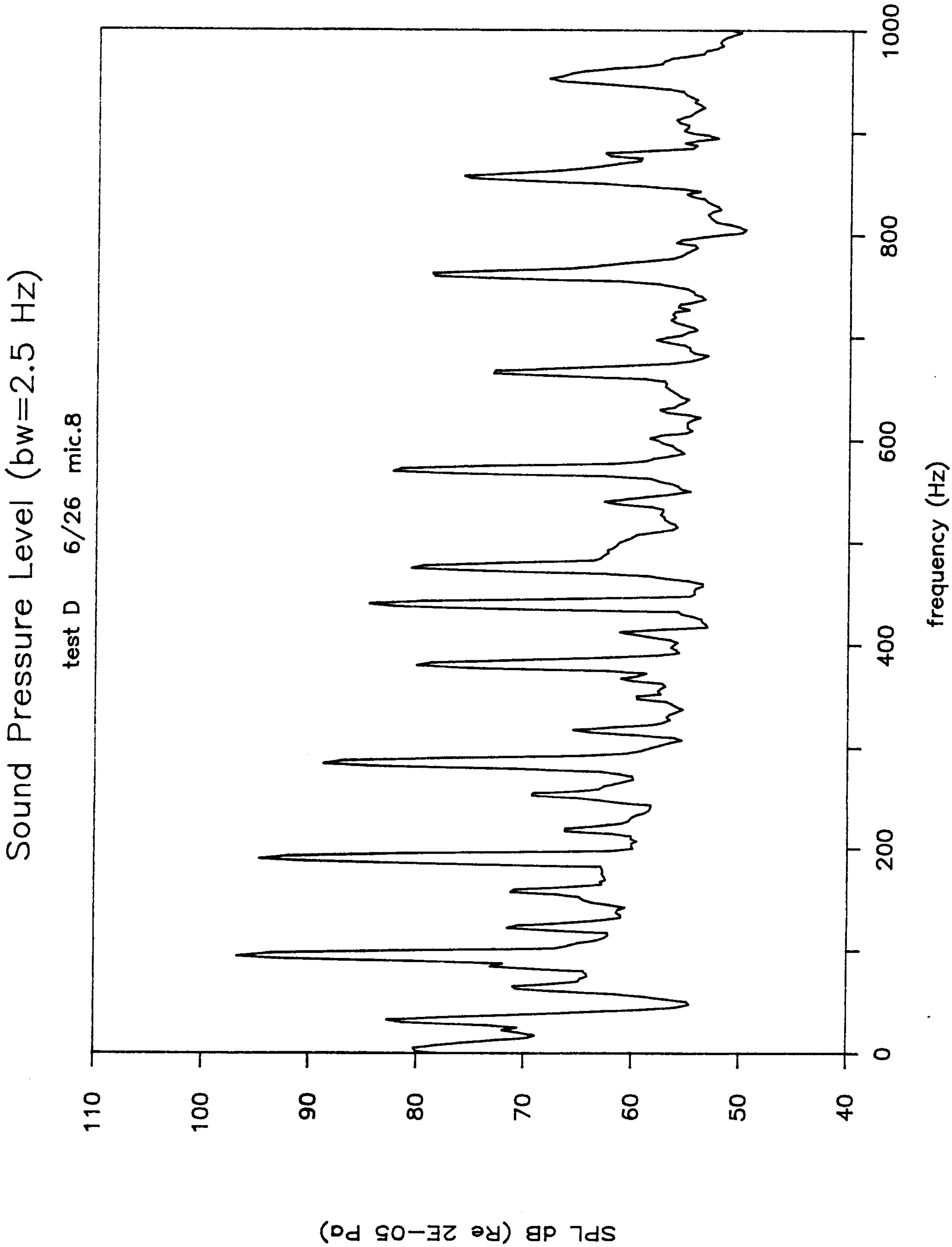
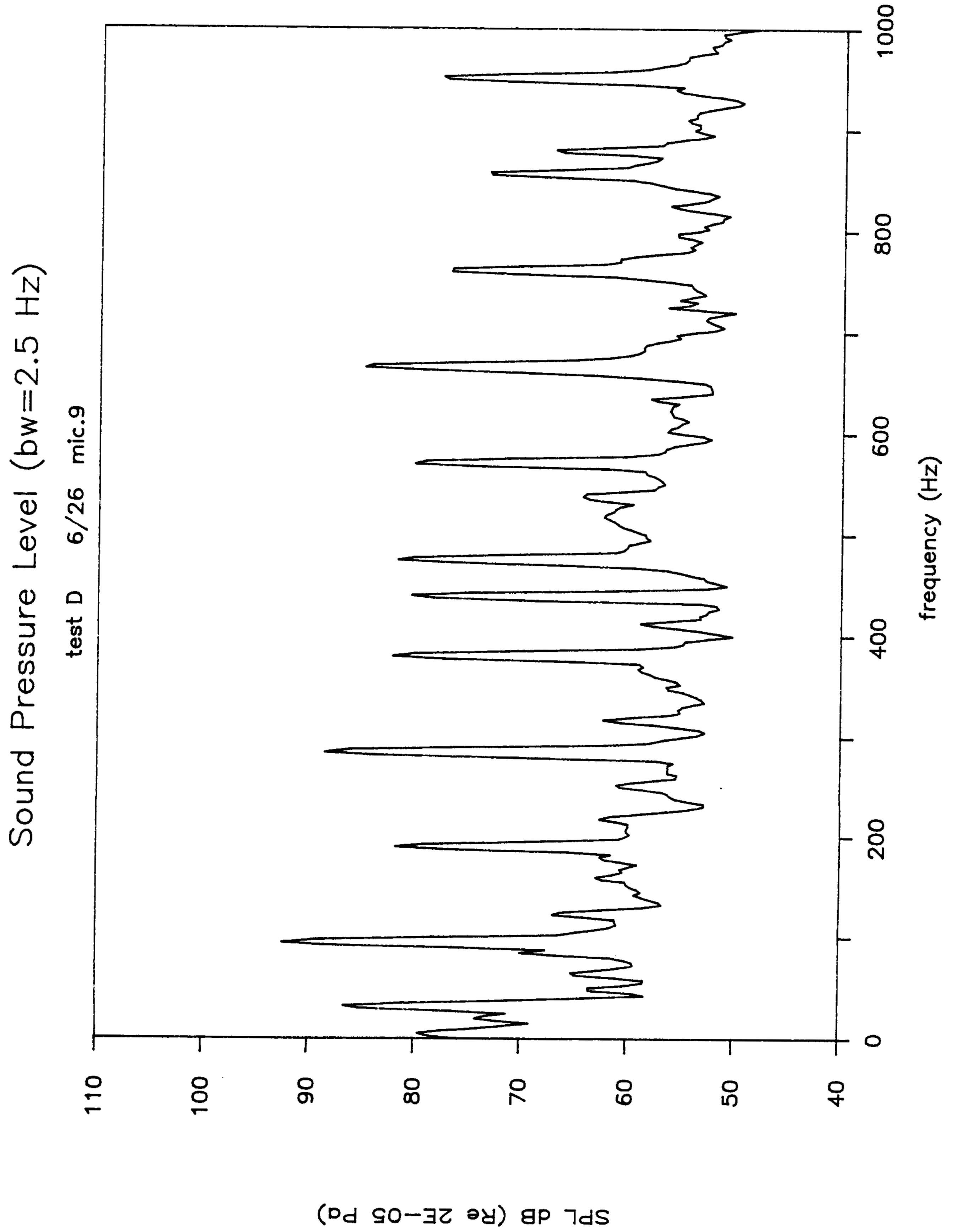
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.7
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.8
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.9
SPL dB (Re 2E−05 Pa)
frequency (Hz)
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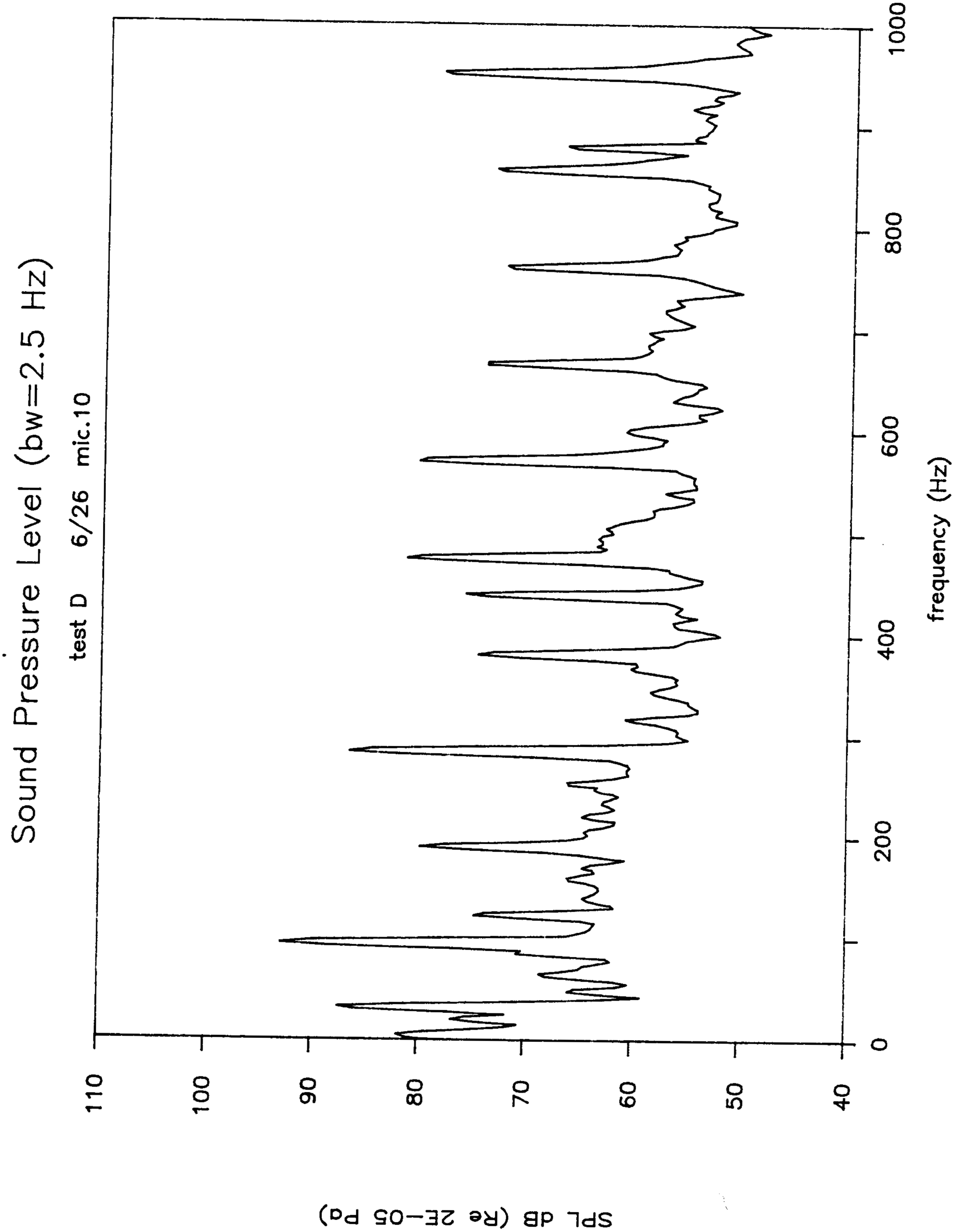
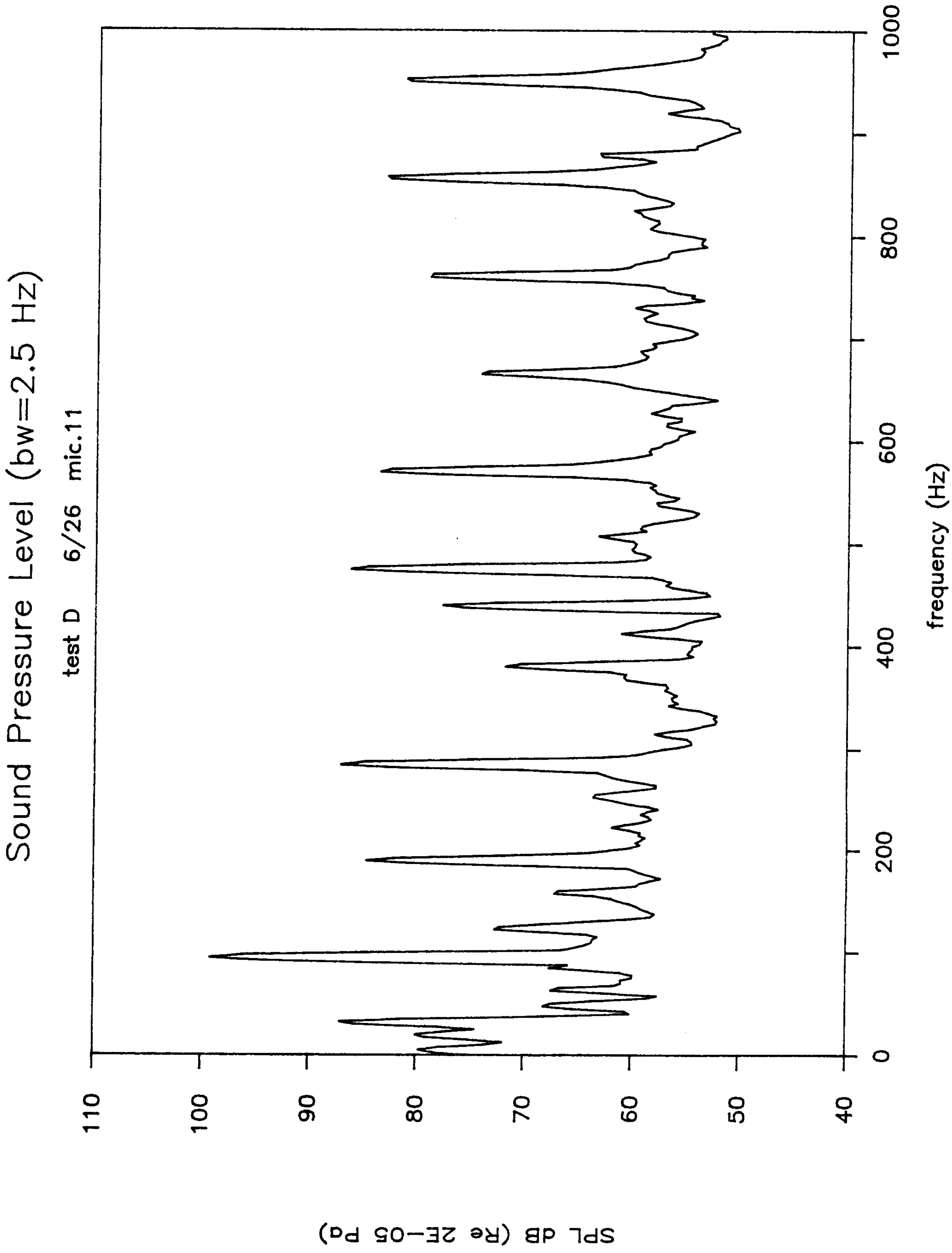
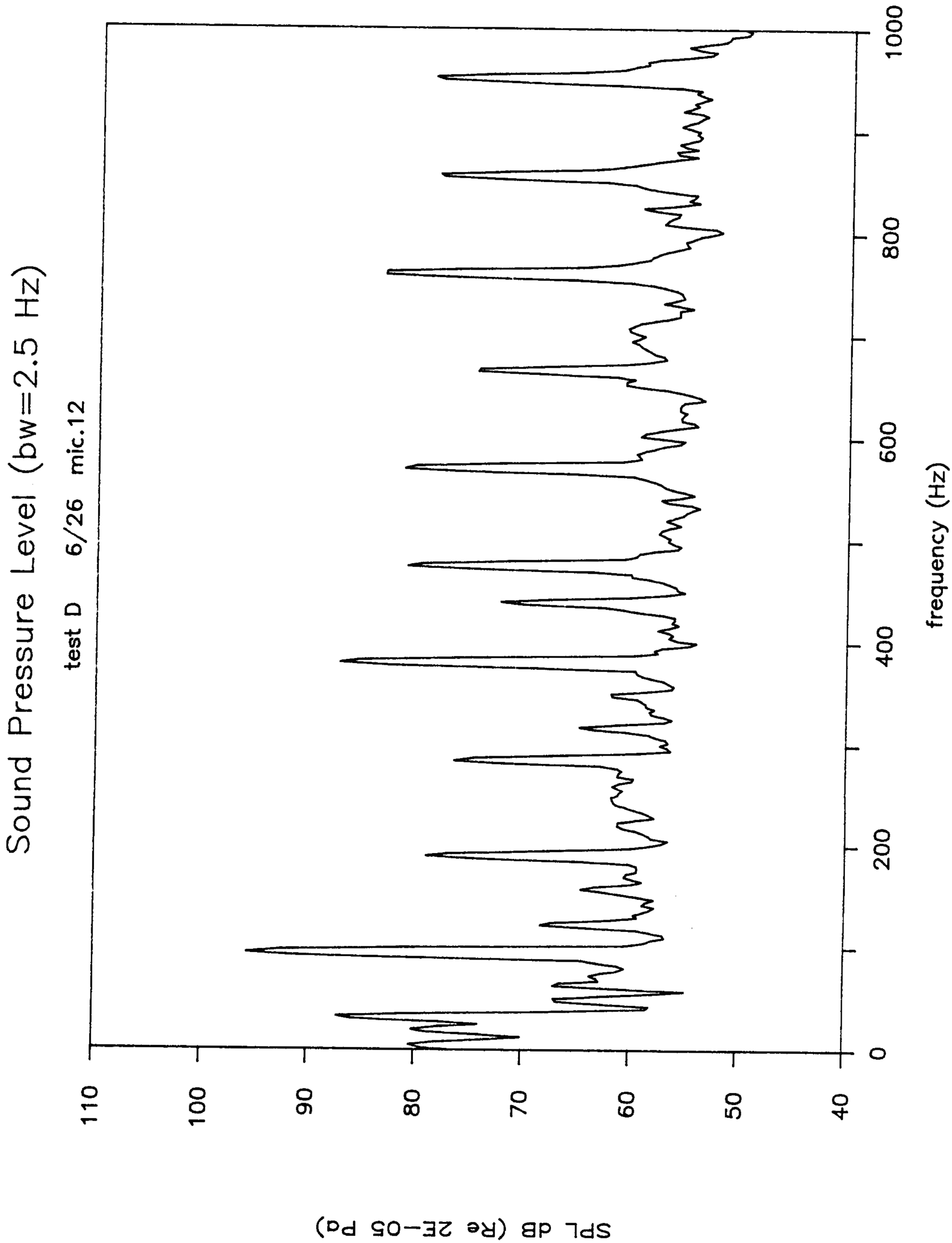
400
600
800
1000
40
50
60
70
80
90
100
110


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.10
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.11
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.12
SPL dB (Re 2E-05 Pa)
frequency (Hz)
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100
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80
70
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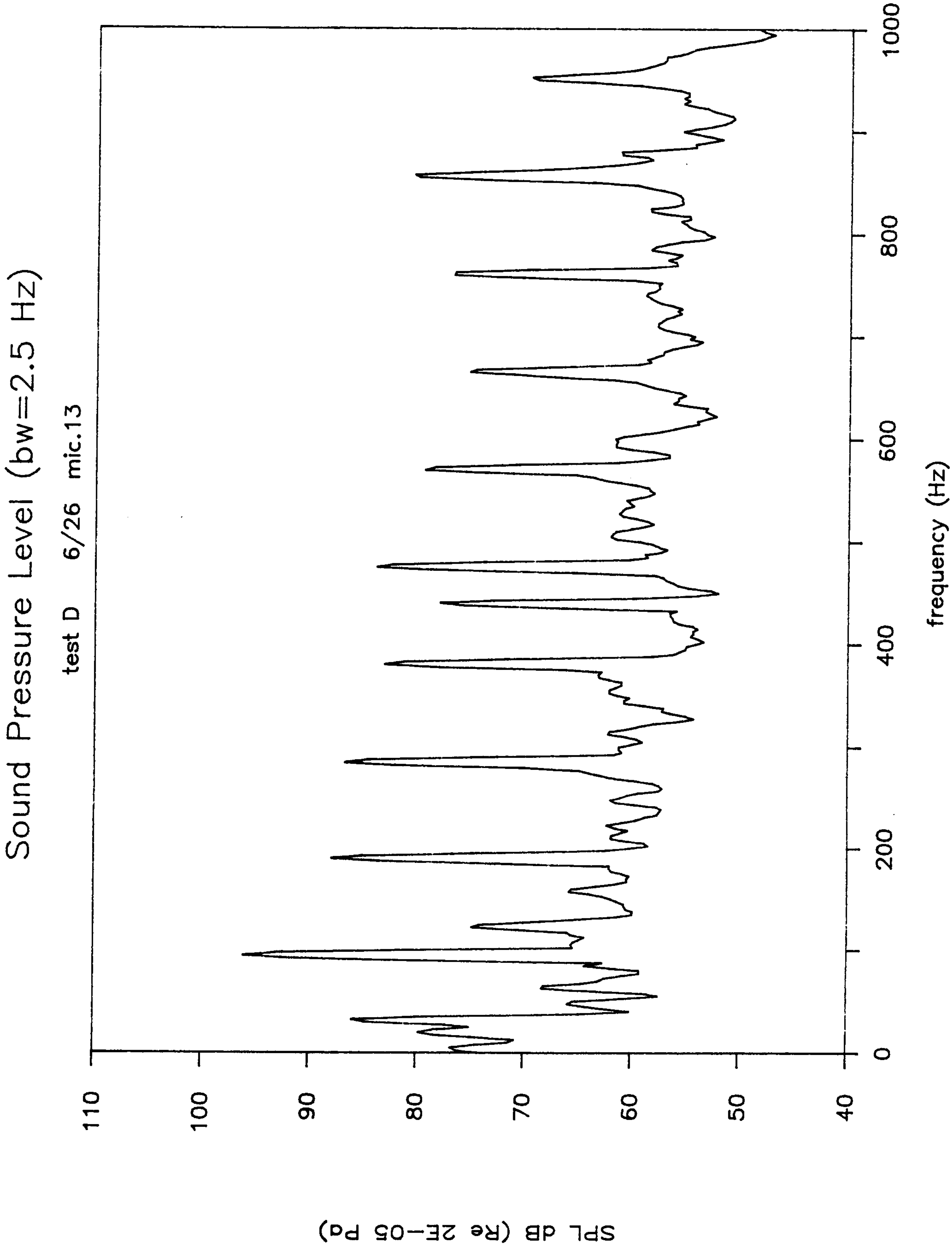
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.13
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
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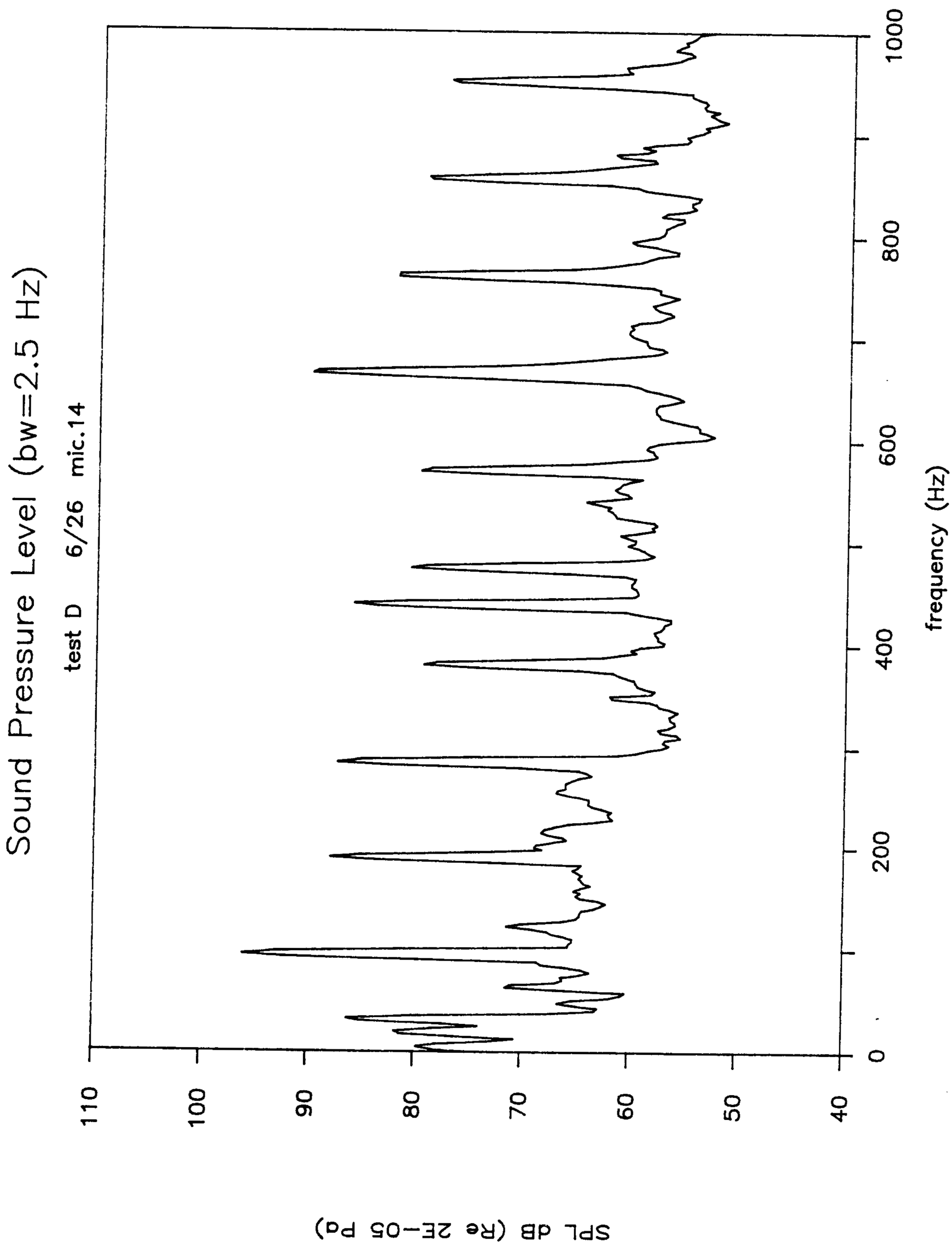
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 6/26 mic.14
SPL dB (Re 2E-05 Pa)
110
100
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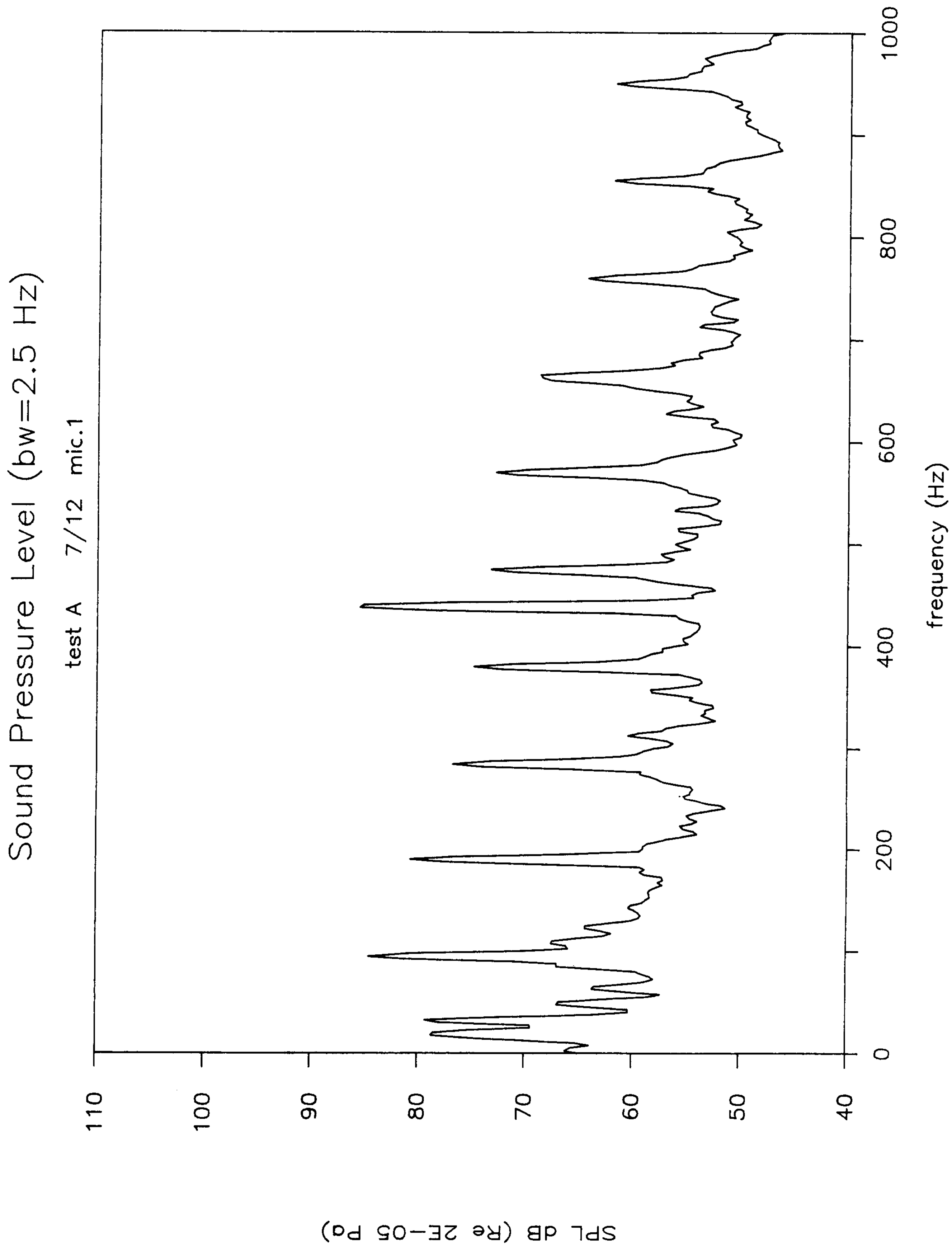
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.1
frequency (Hz)
SPL dB (Re 2E-05 Pa)
0
200
400
600
800
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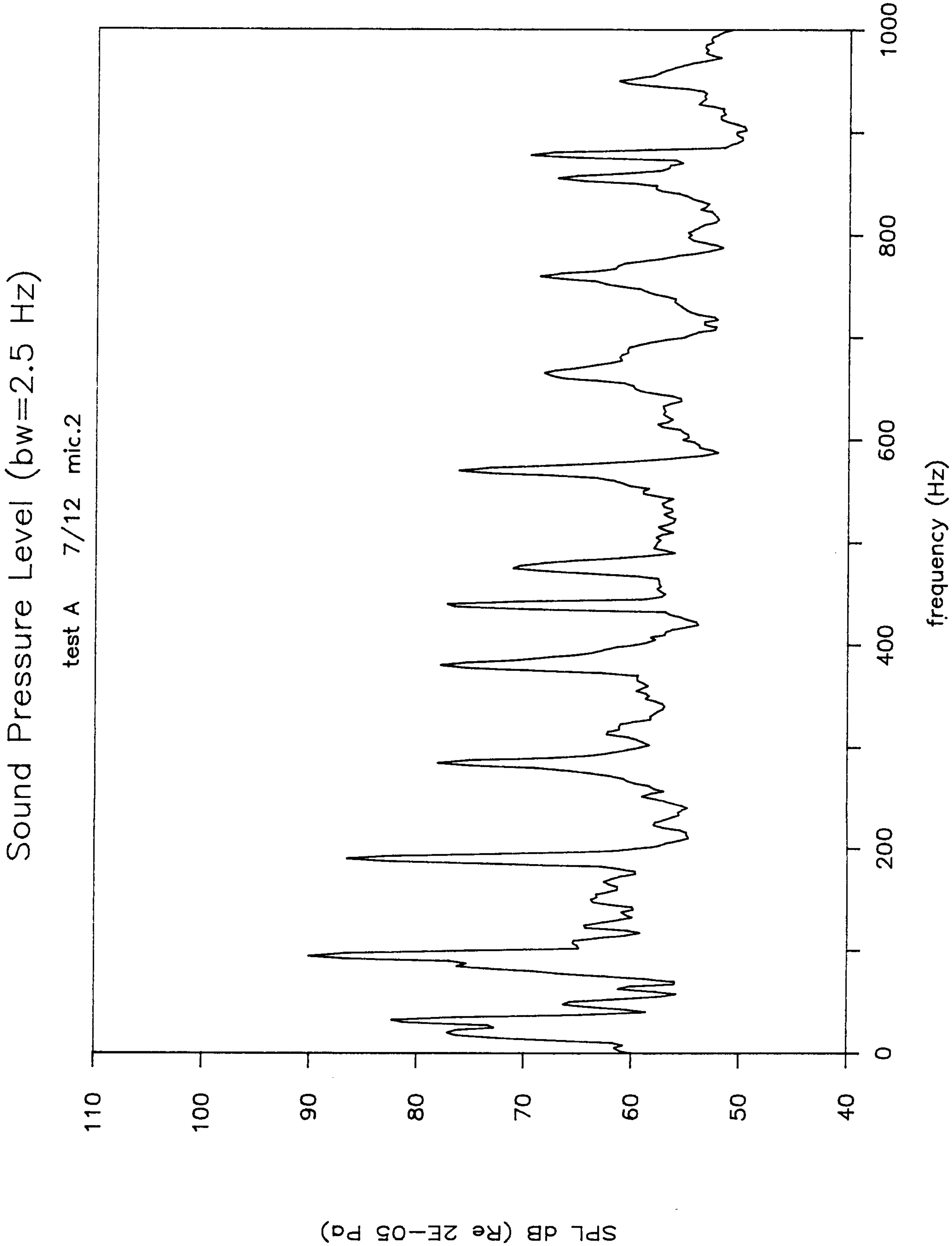
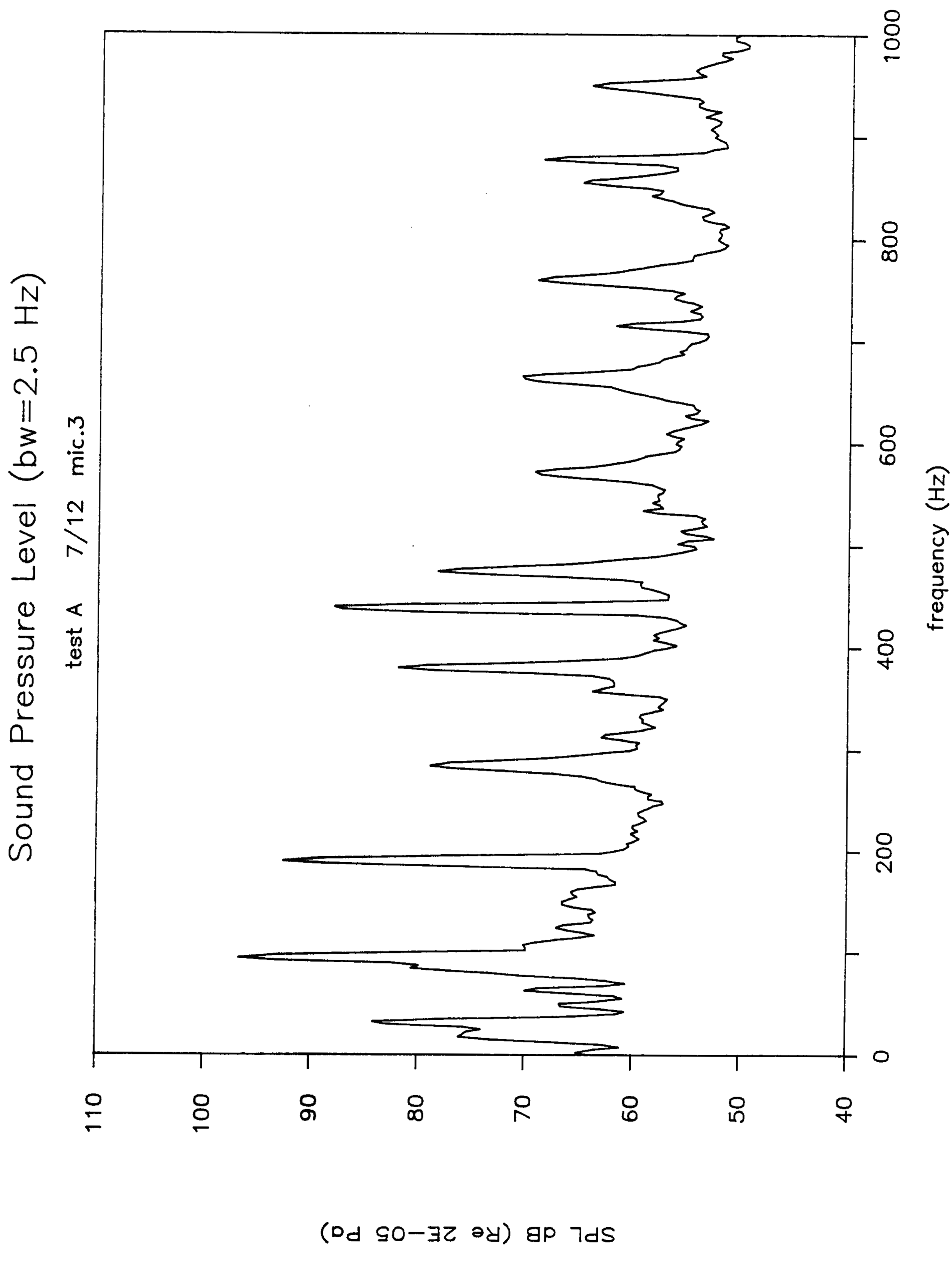
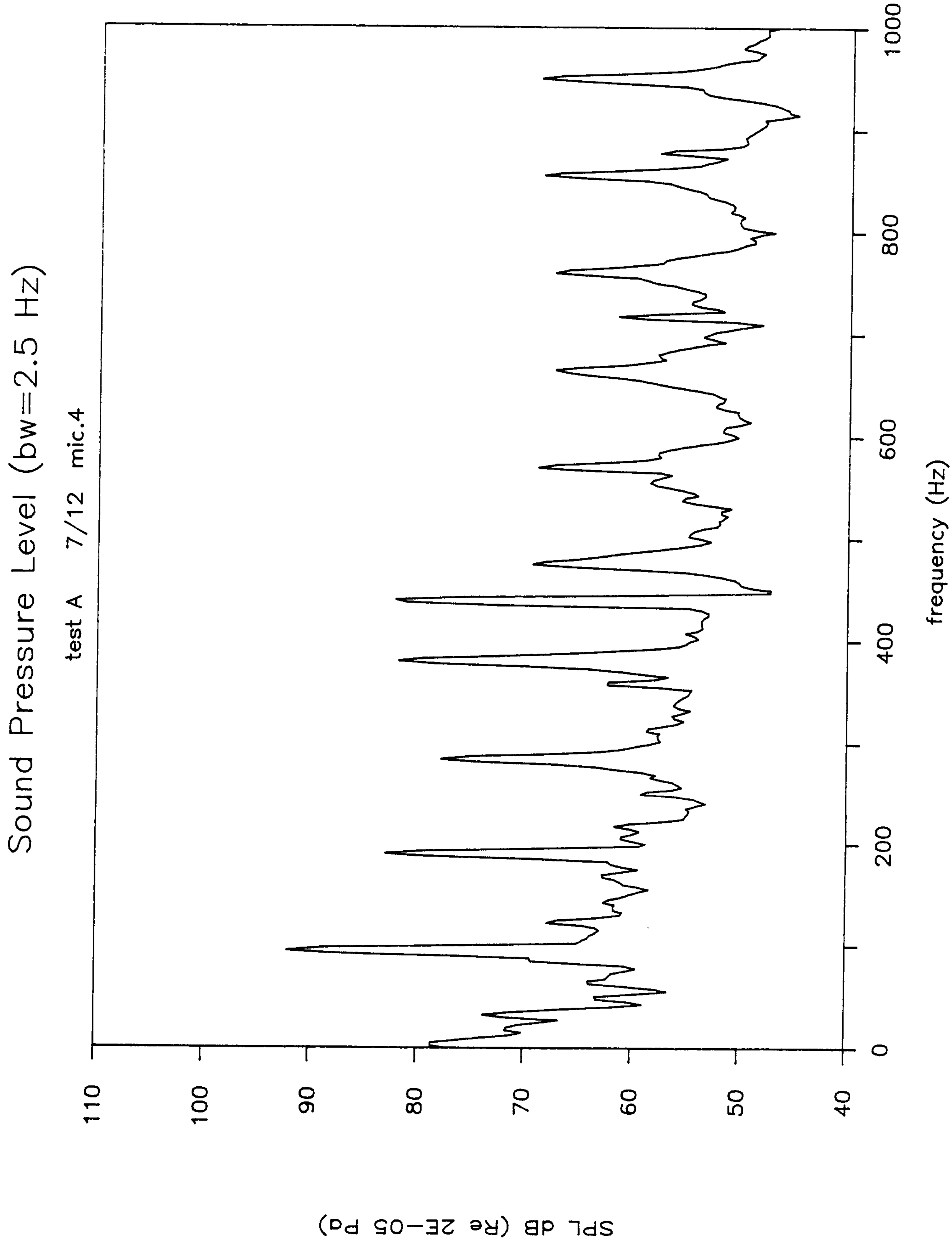
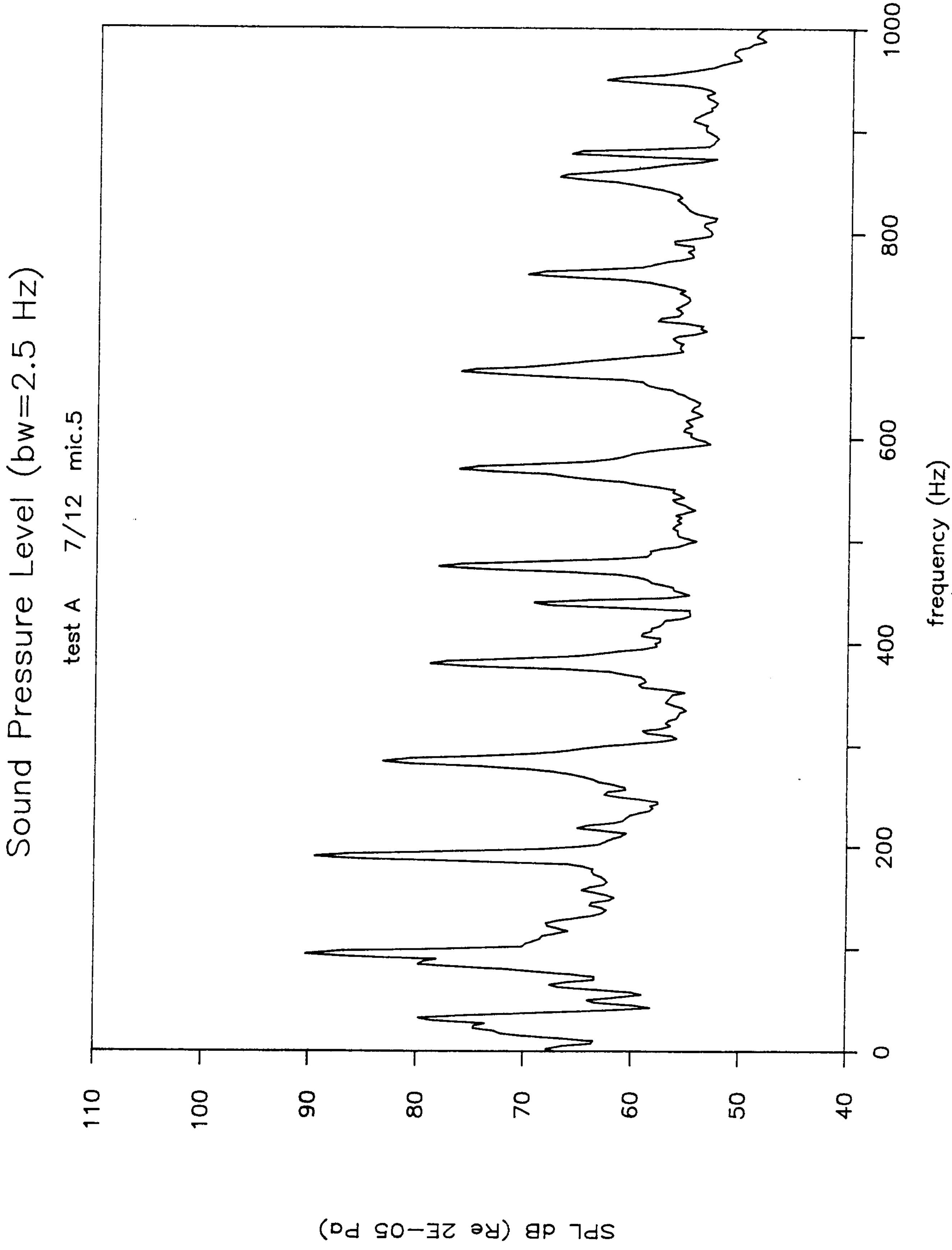
70
80
90
100
110

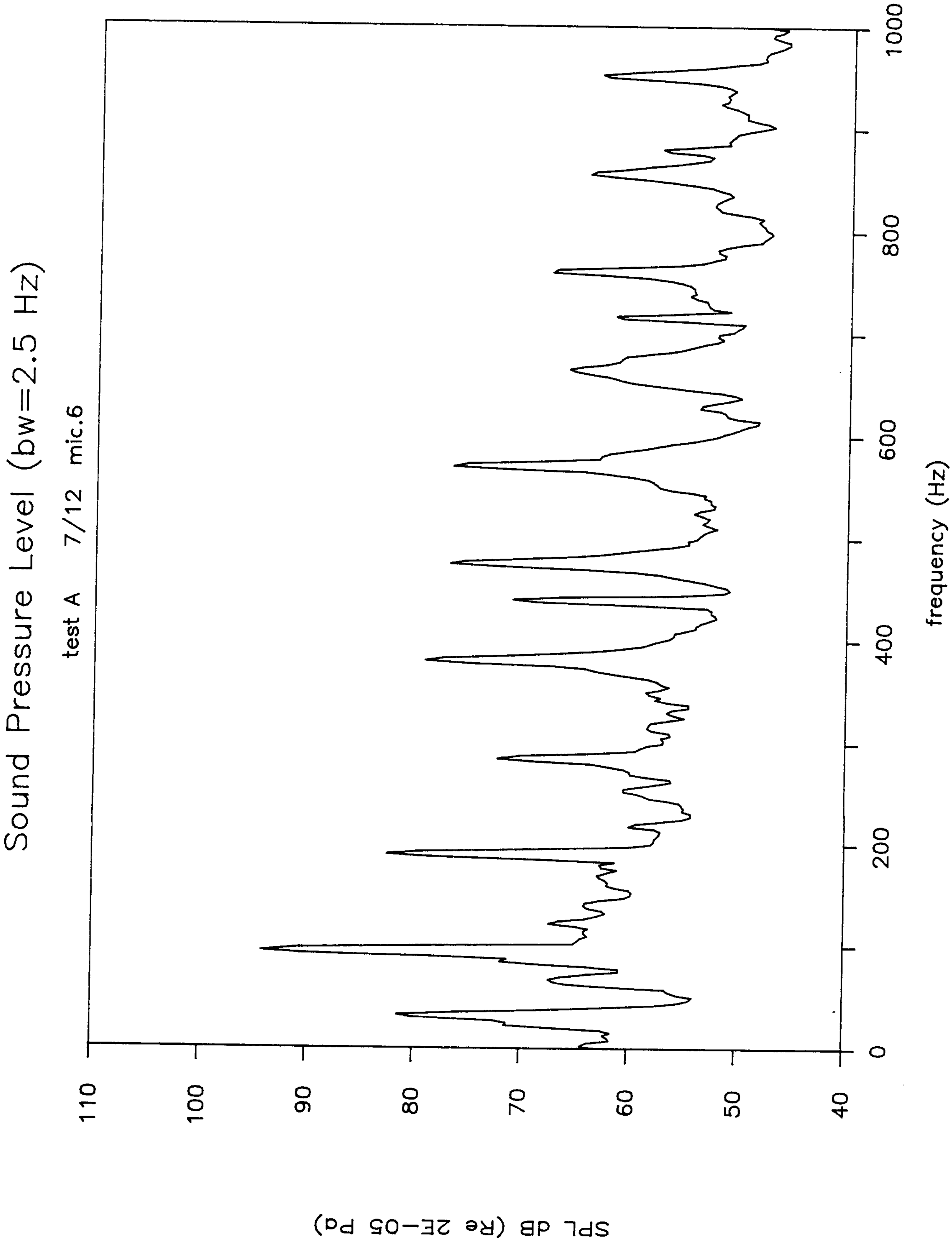

Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.2
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

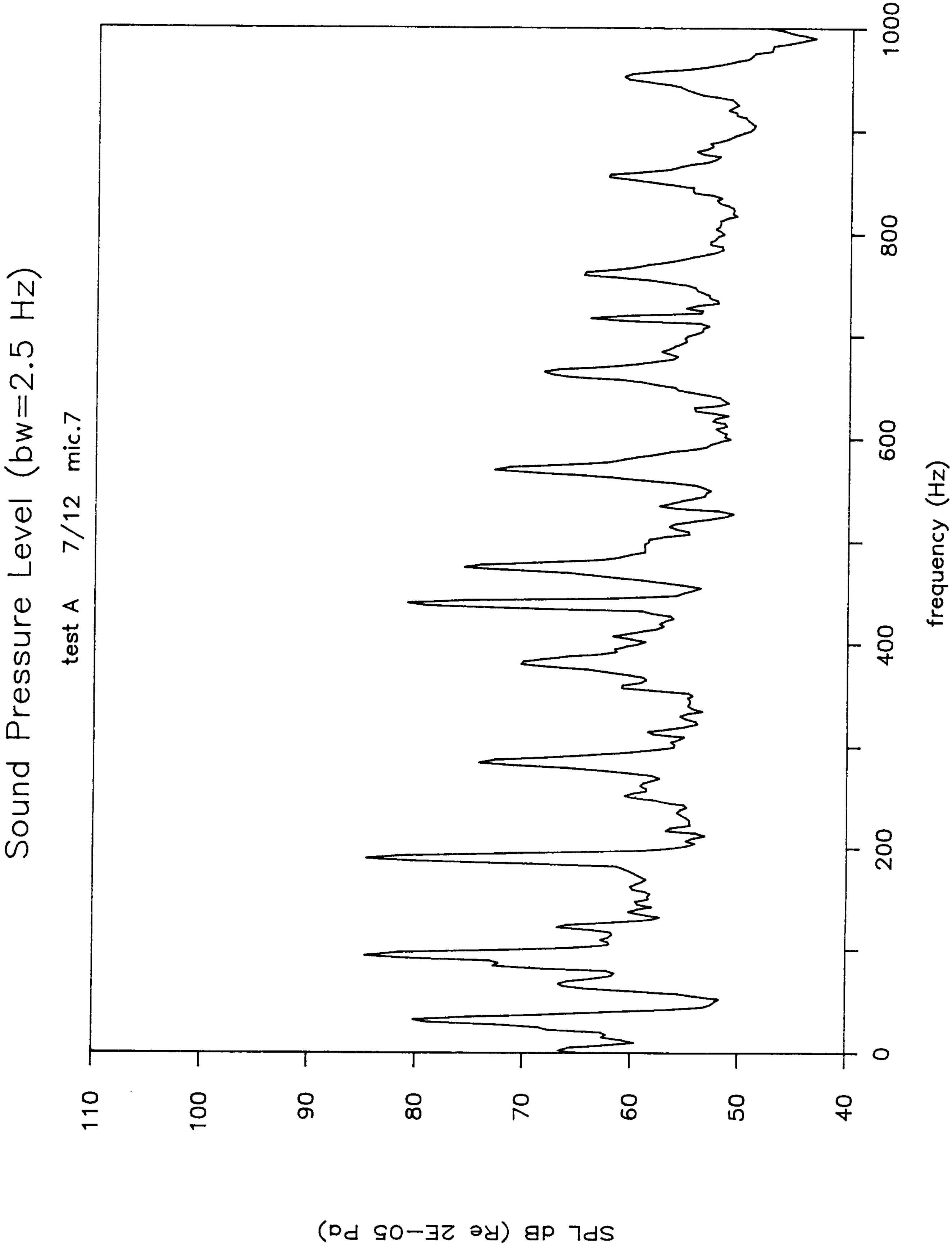

Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.3
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.4
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000



Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.5
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.6
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)



Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.7
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
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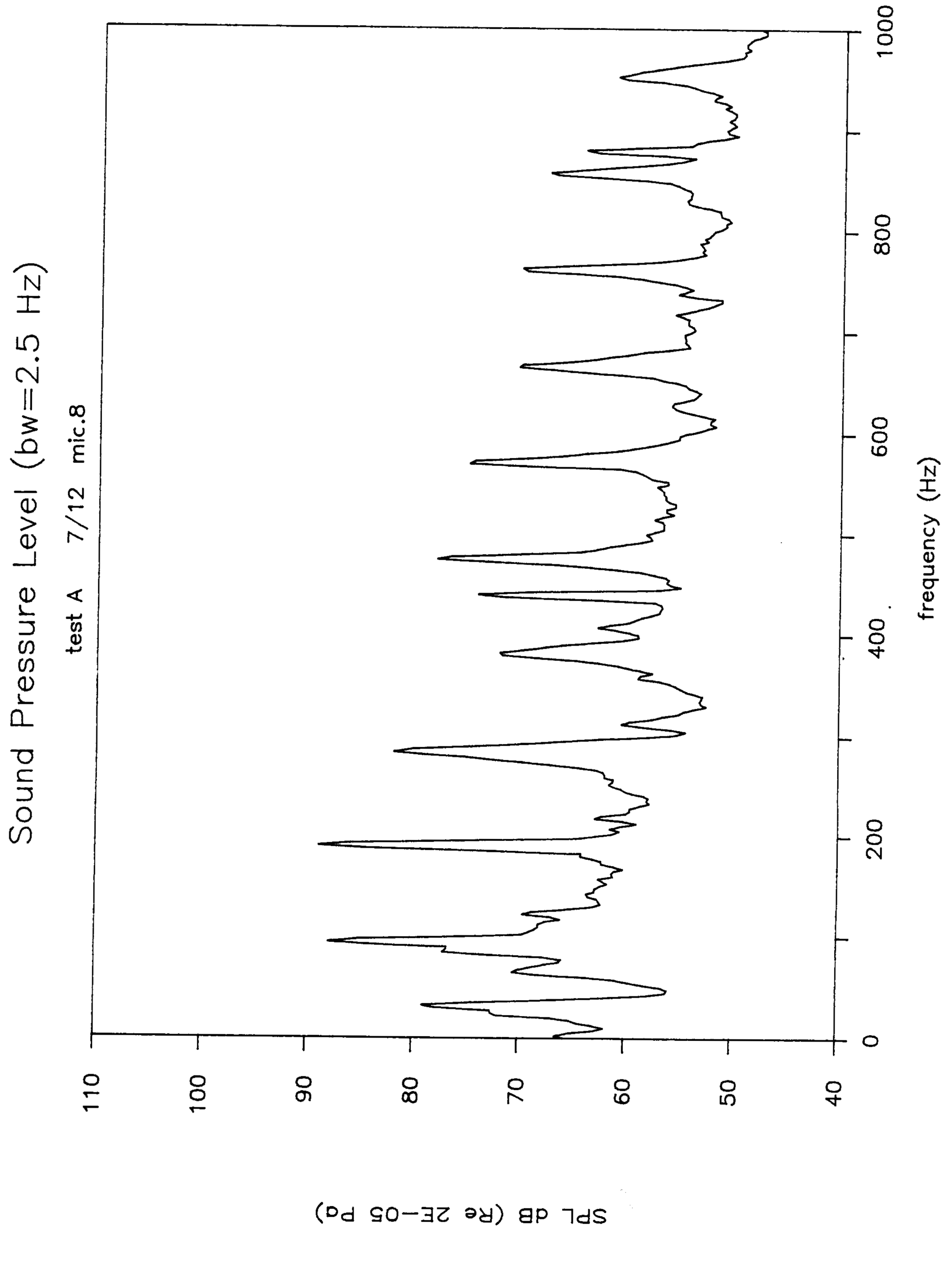
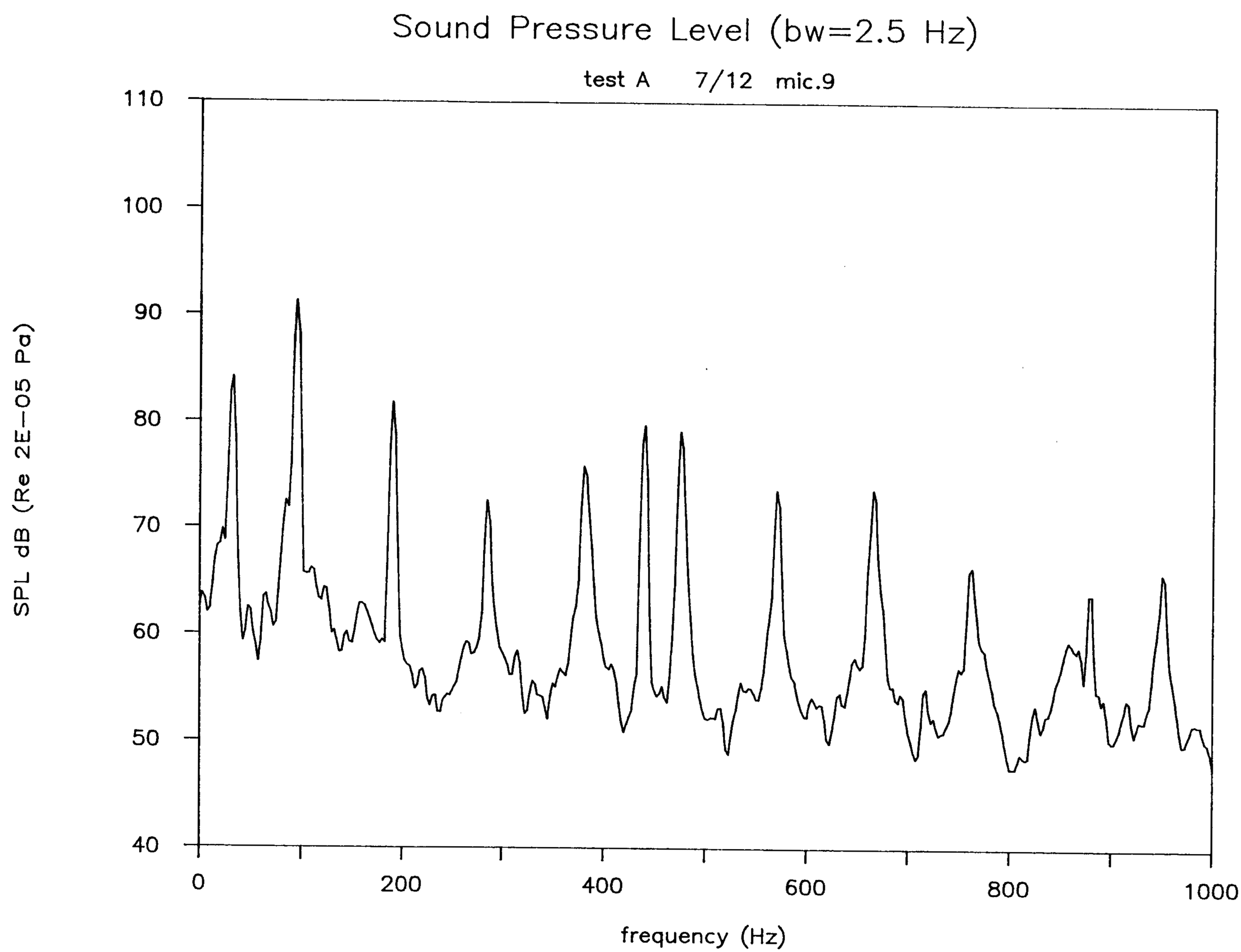
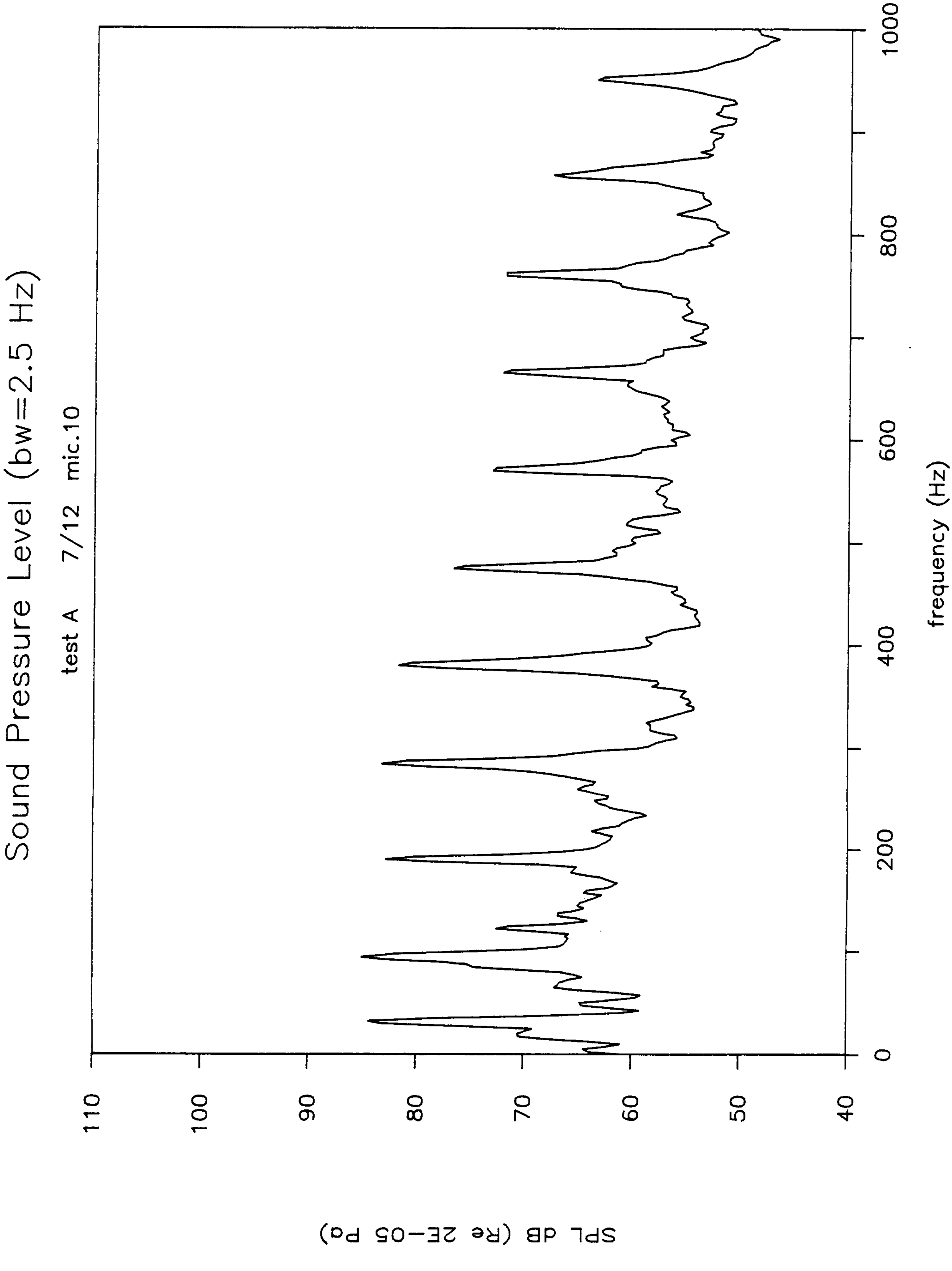
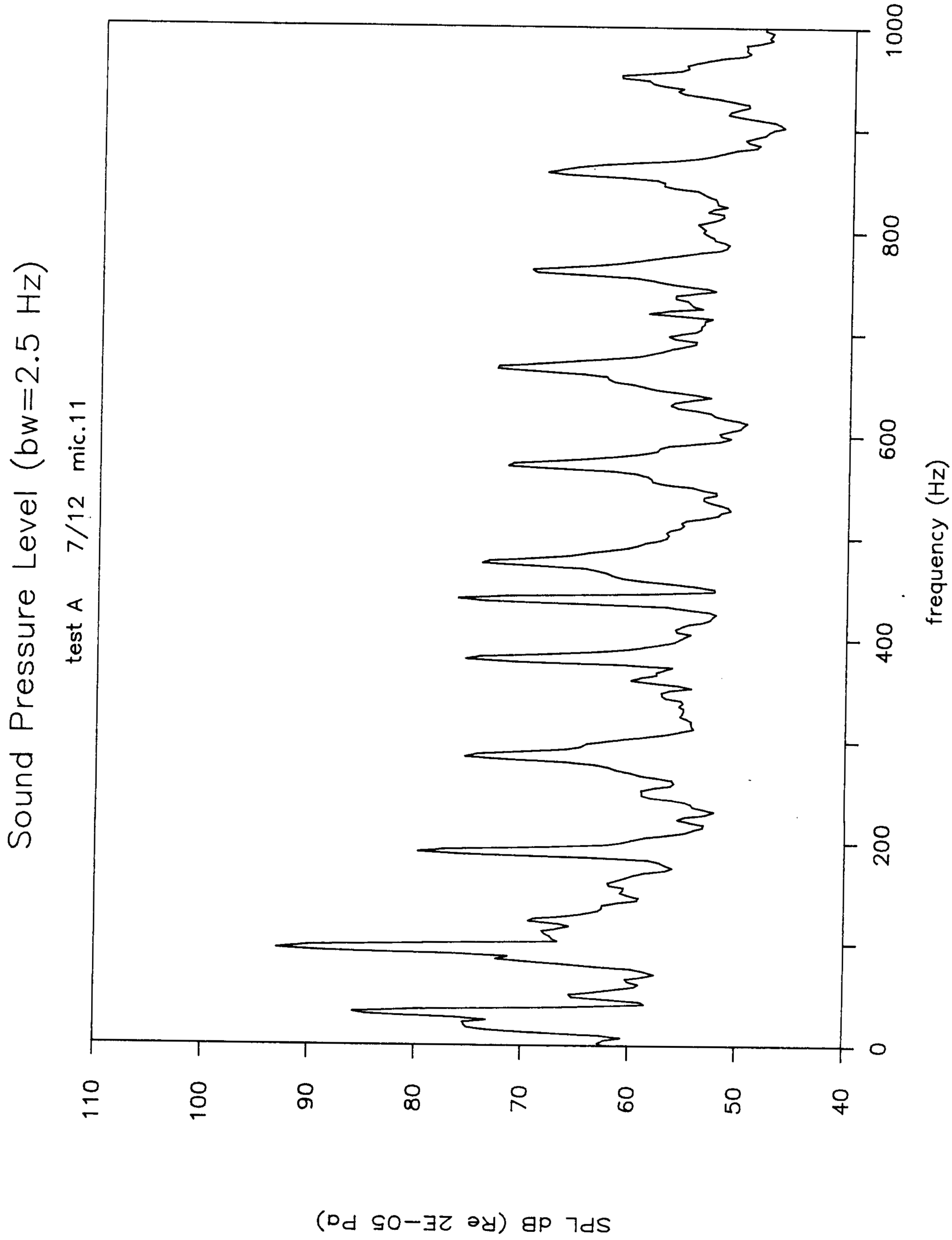
80
70
60
50
40
0
200
400
600
800
1000

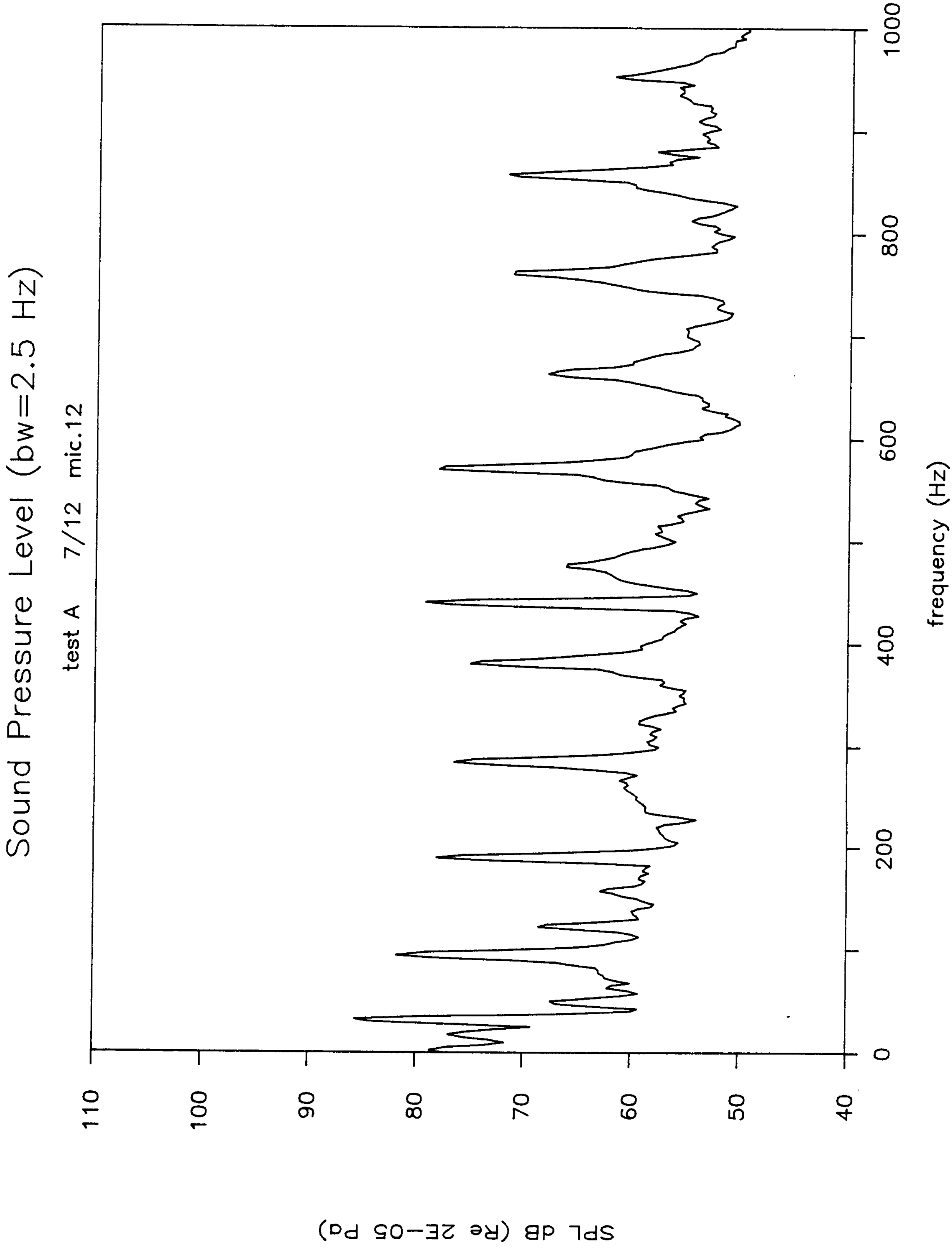

Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.8
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.9
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)



Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.10
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.11
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.12
SPL dB (Re 2E-05 Pa)
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100
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80
70
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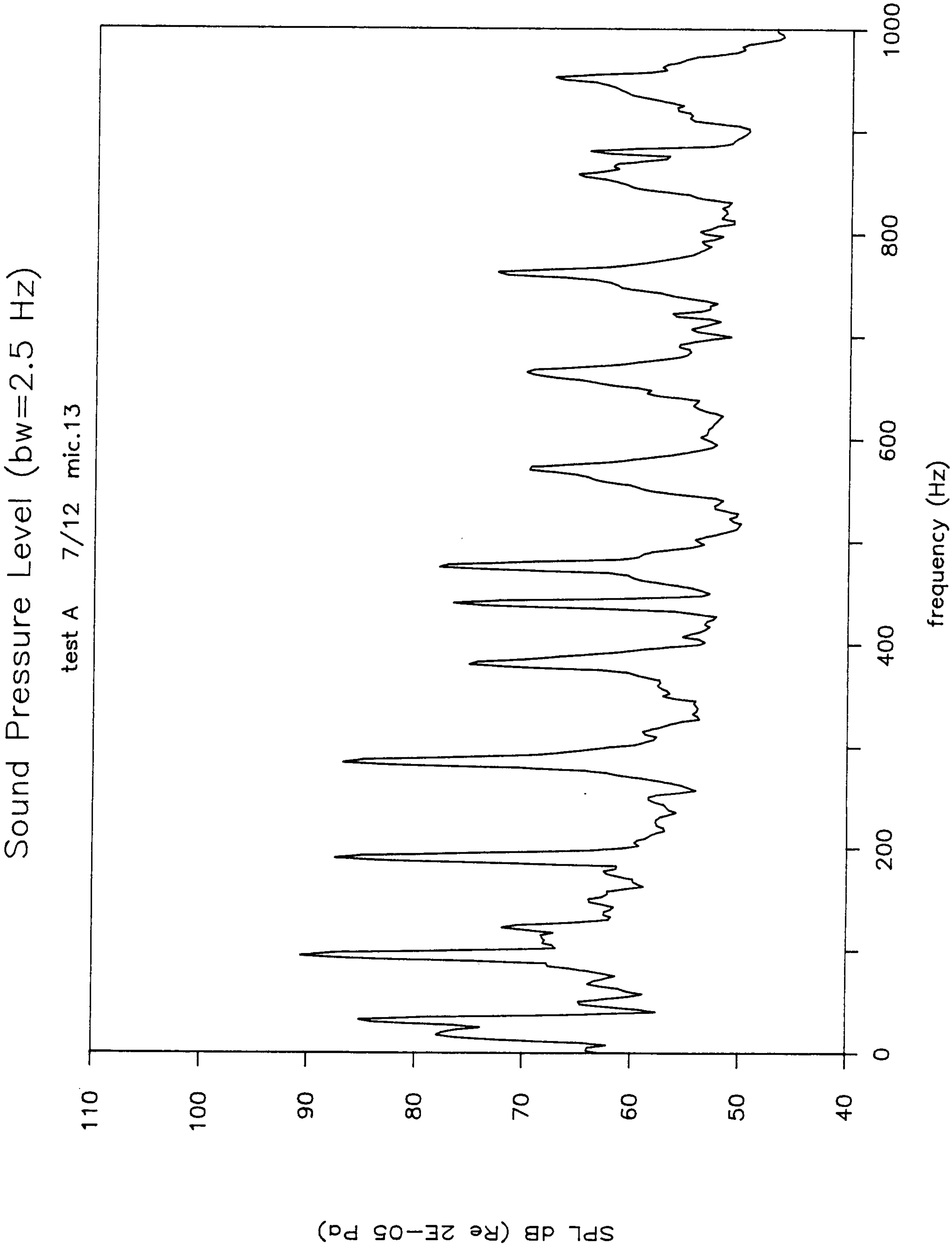
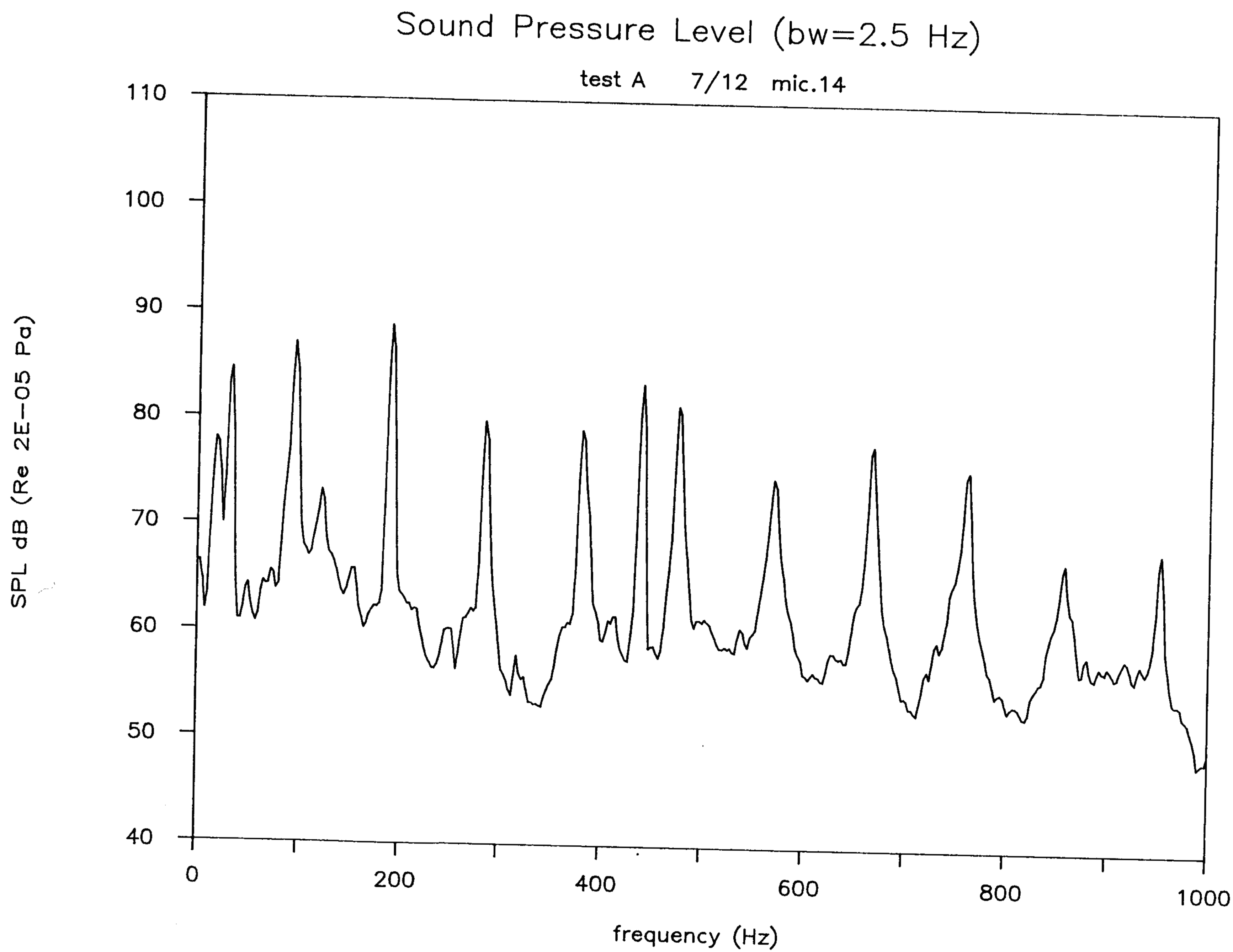
0
200
400
600
800
1000
frequency (Hz)



Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.13
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test A 7/12 mic.14
SPL dB (Re 2E-05 Pa)
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100
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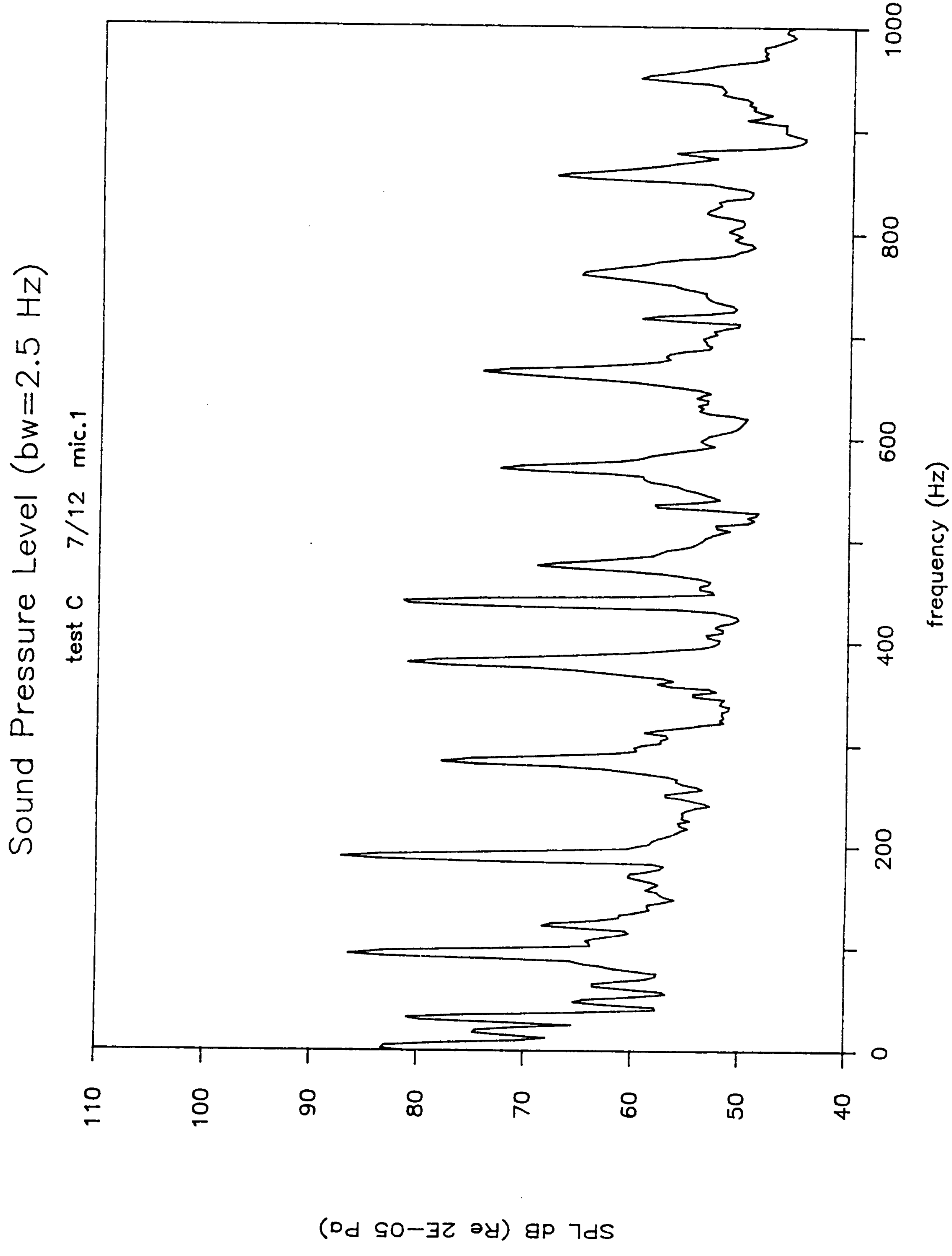
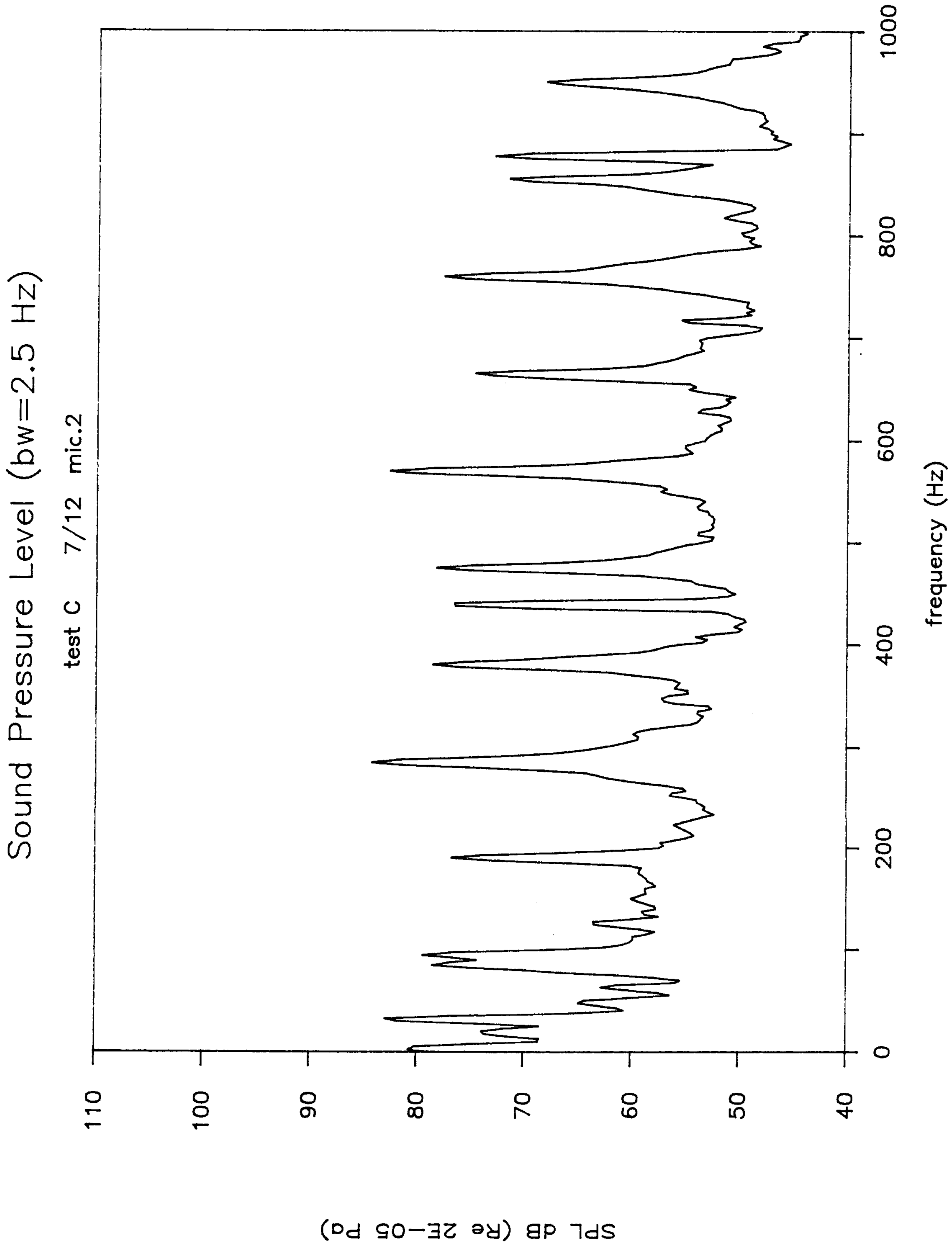
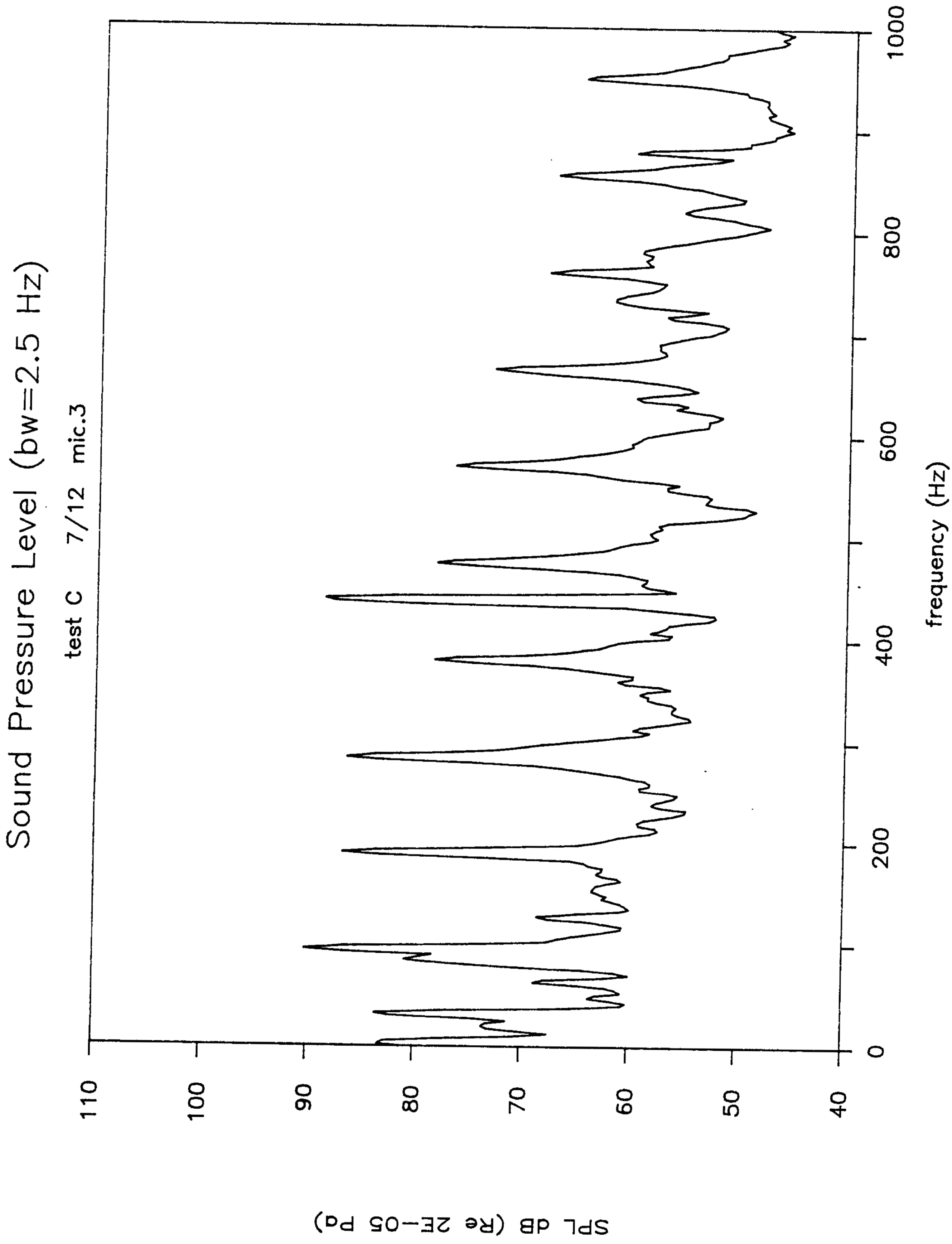
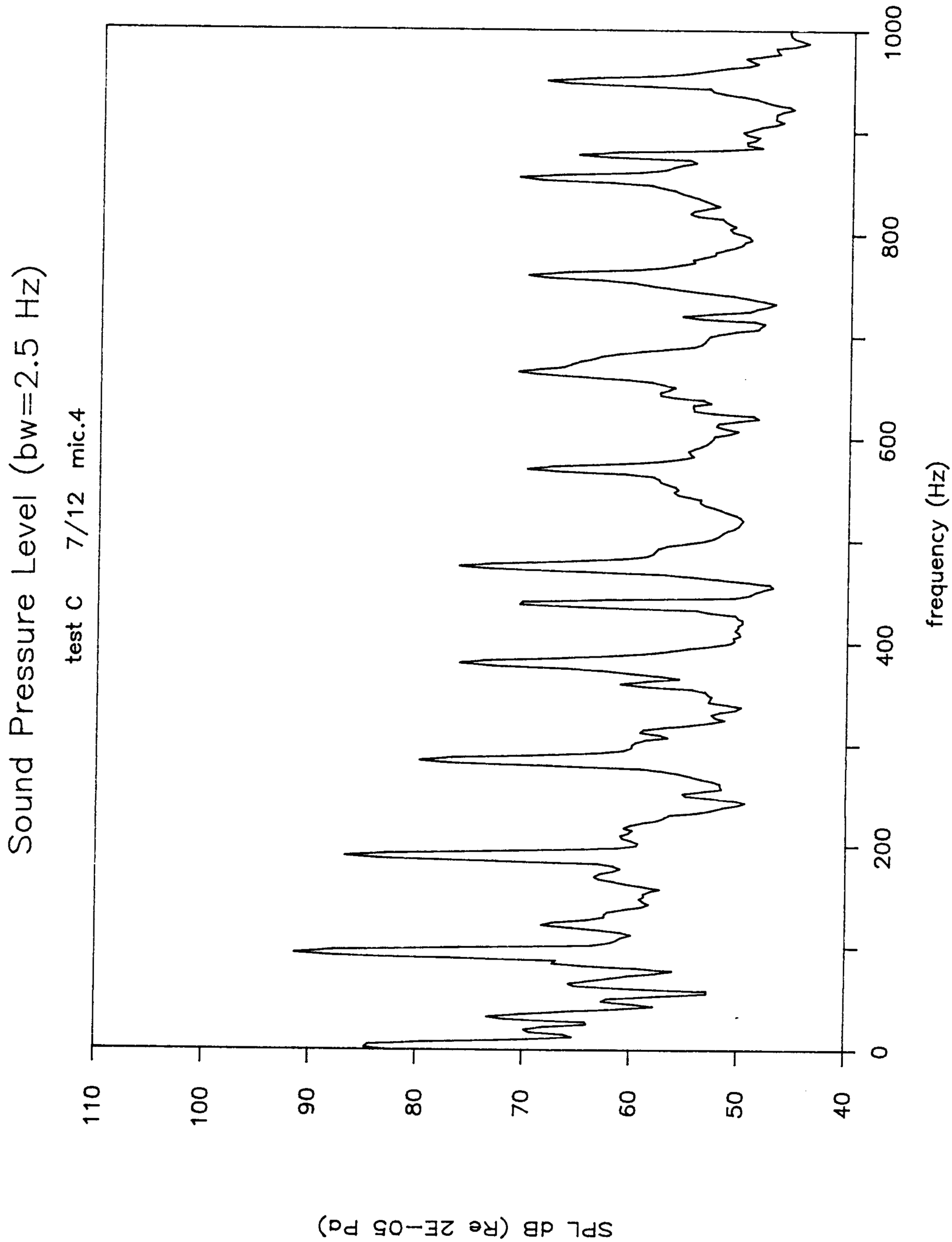
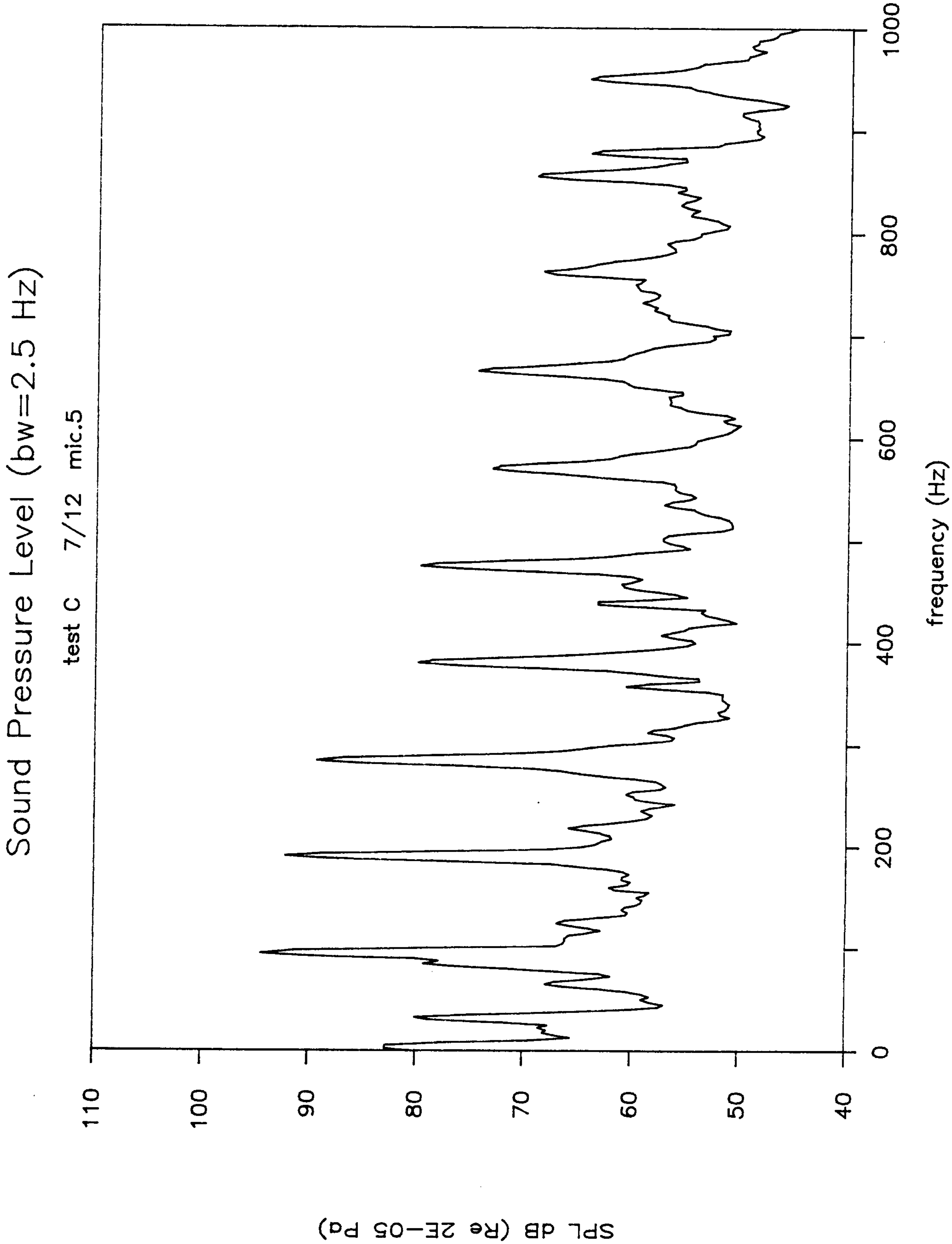
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

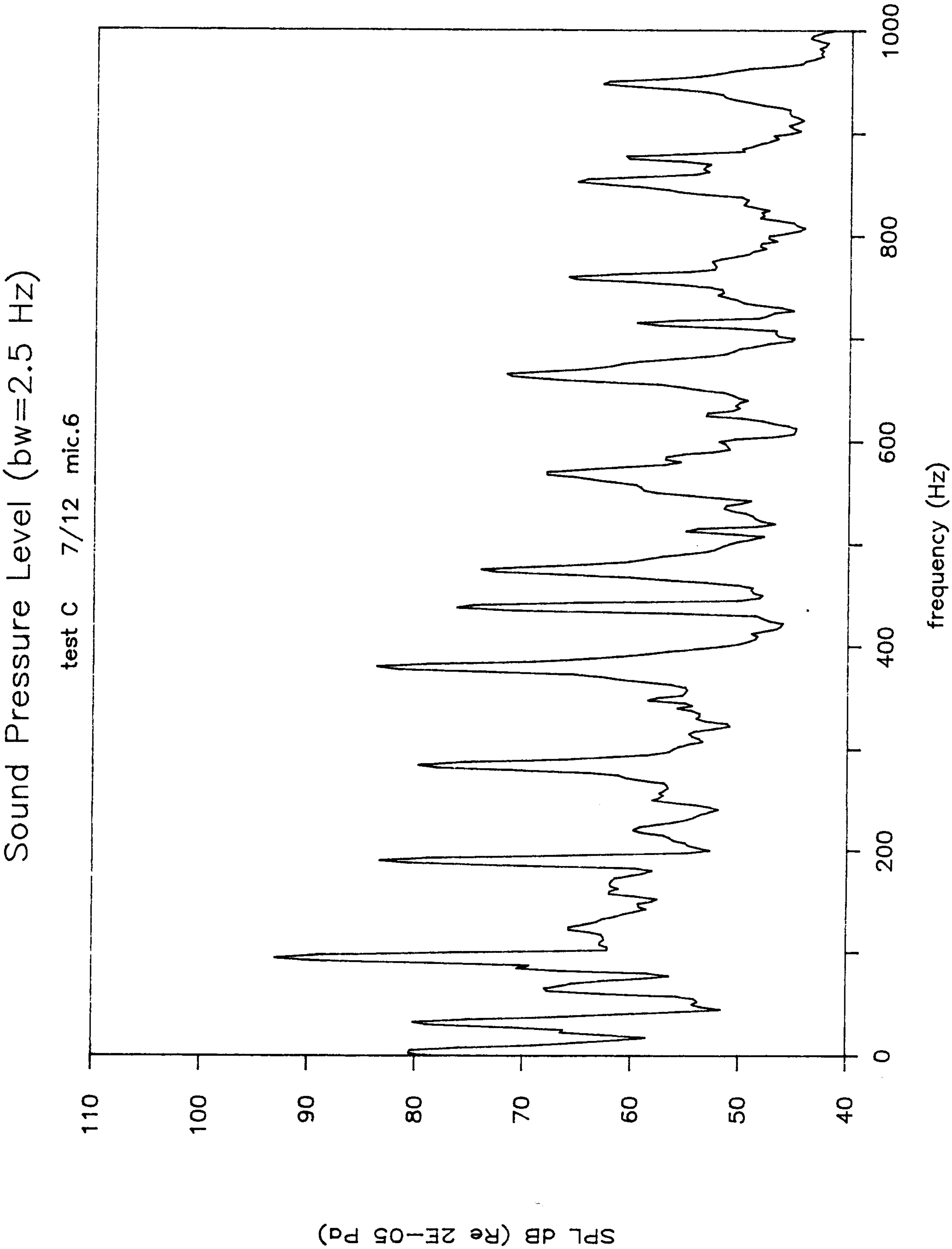

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.1
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

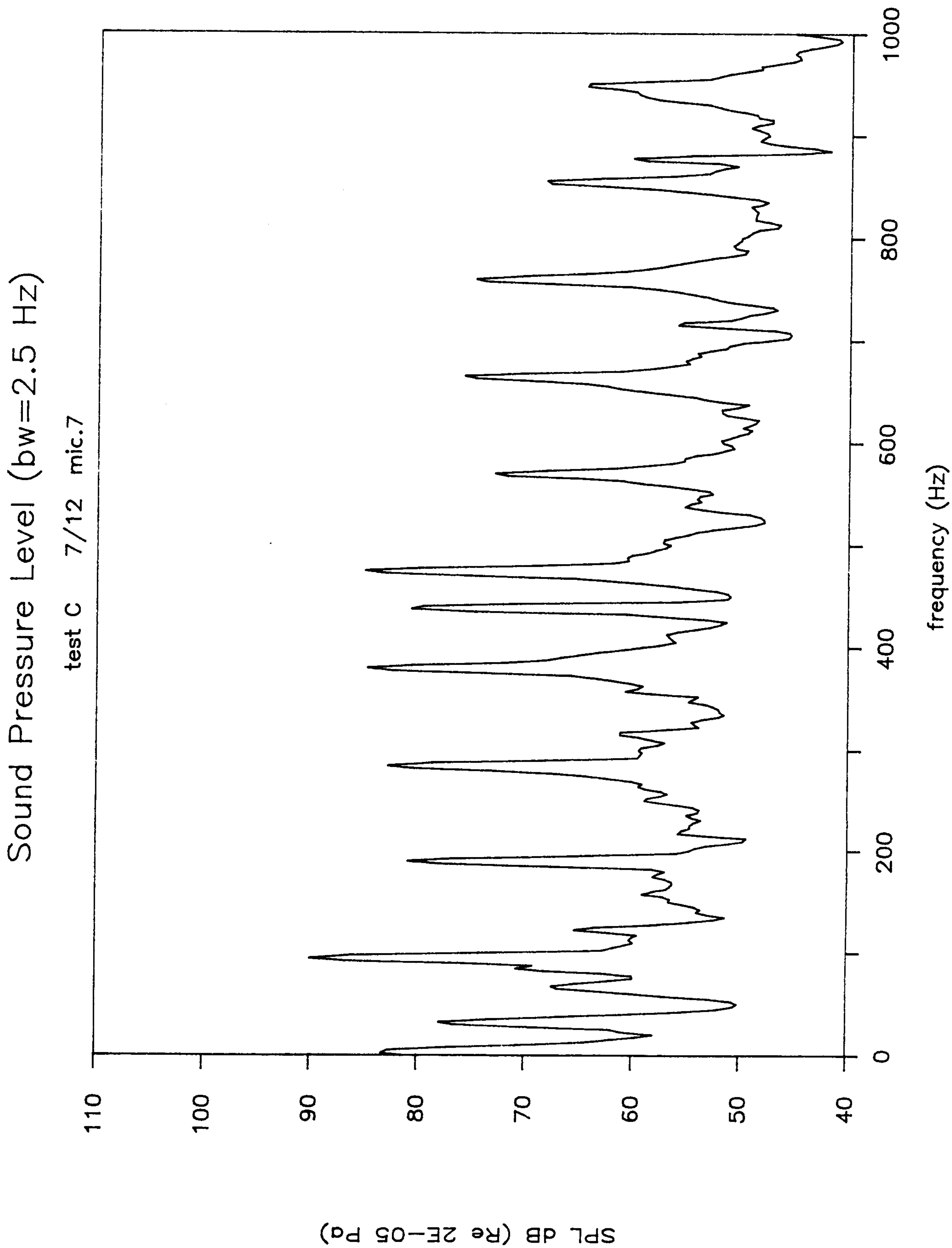

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.2
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

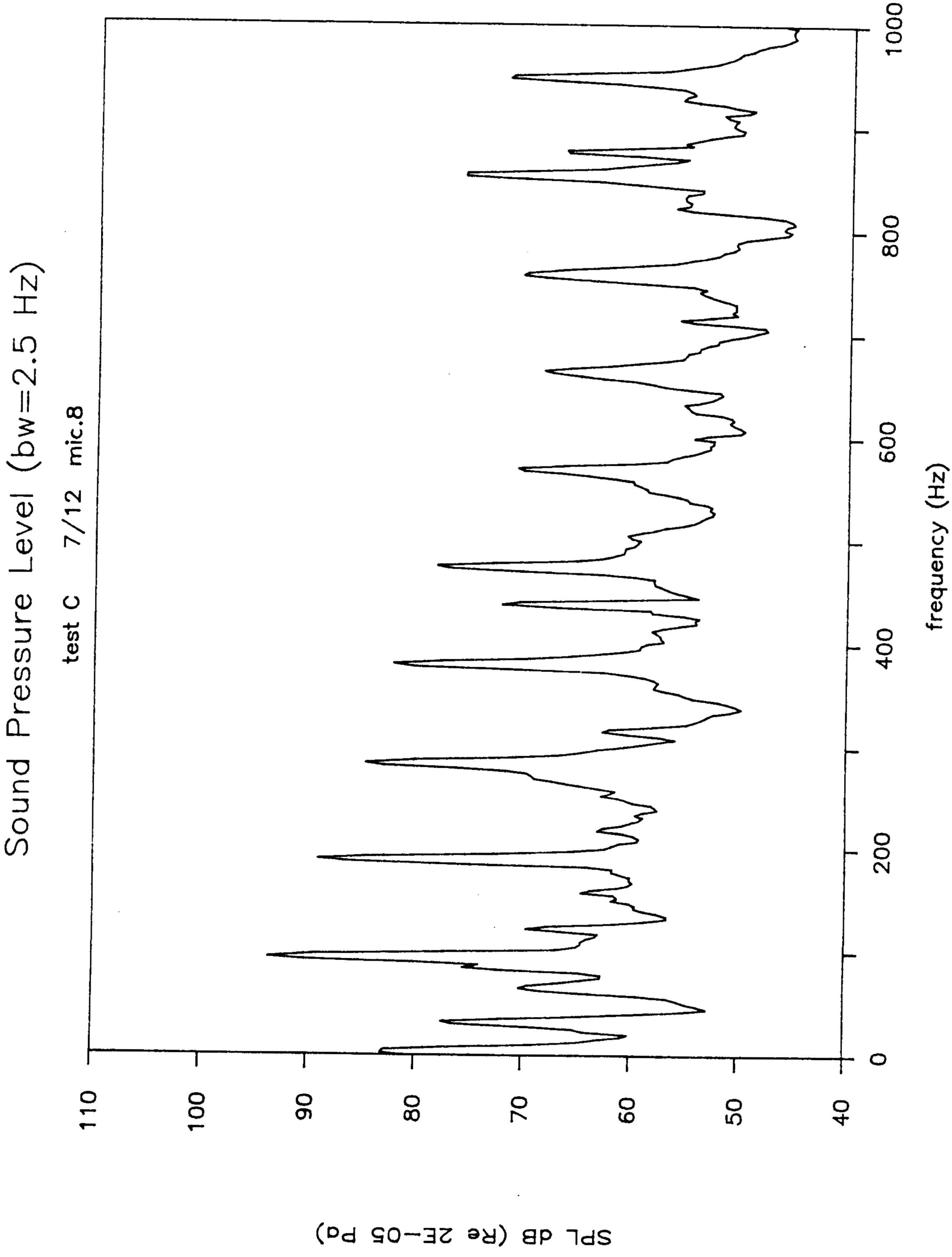

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.3
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

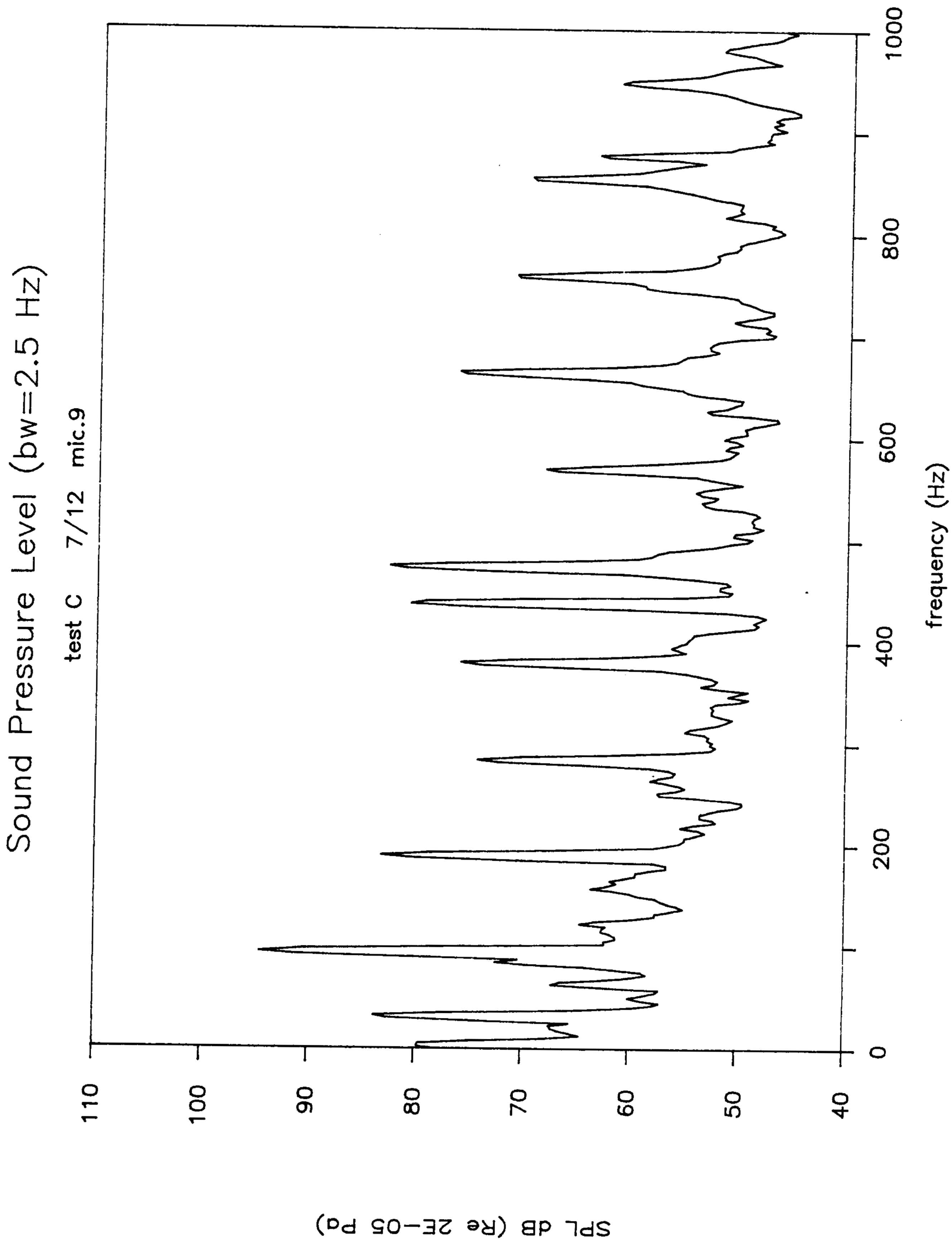

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.4
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

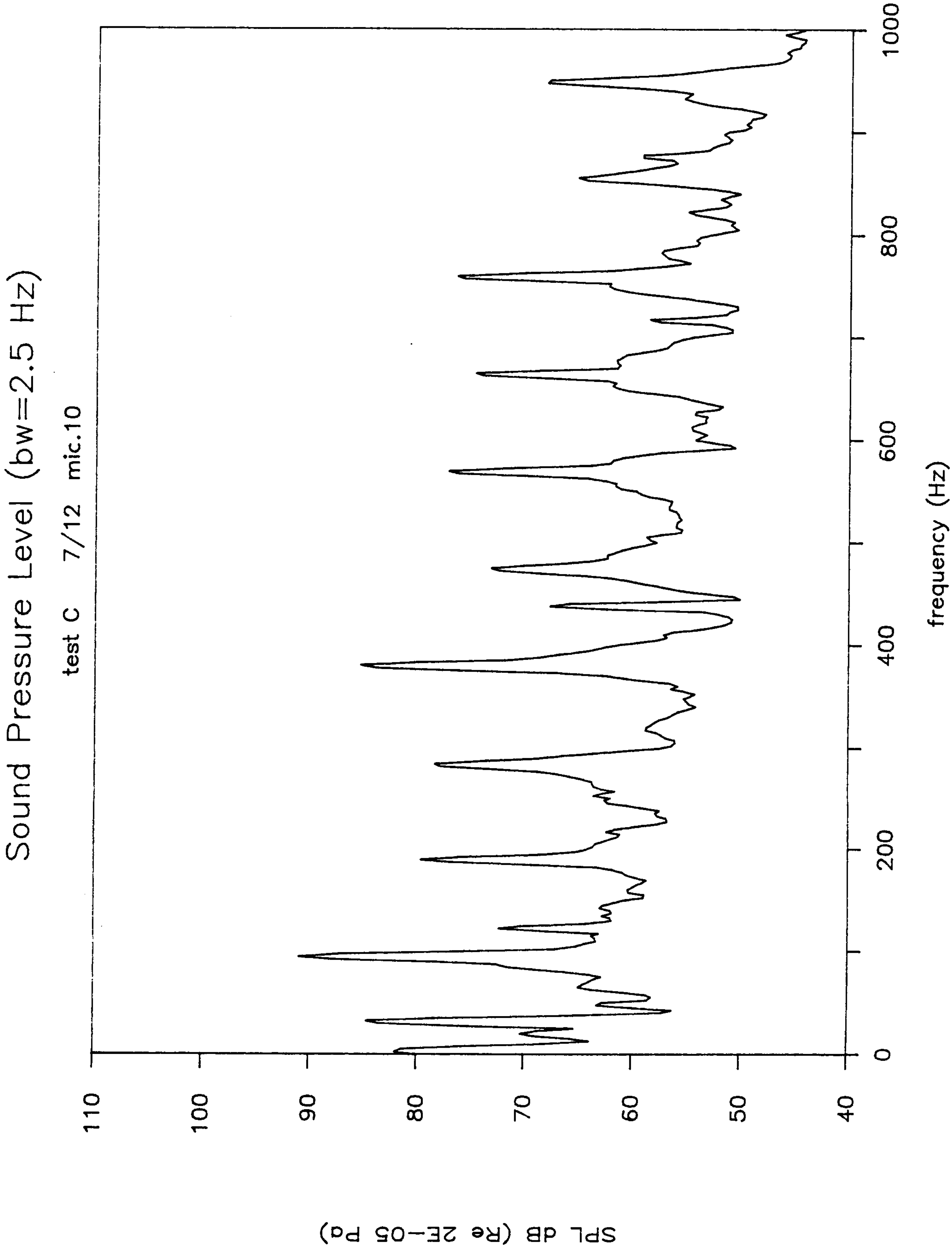

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.5
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

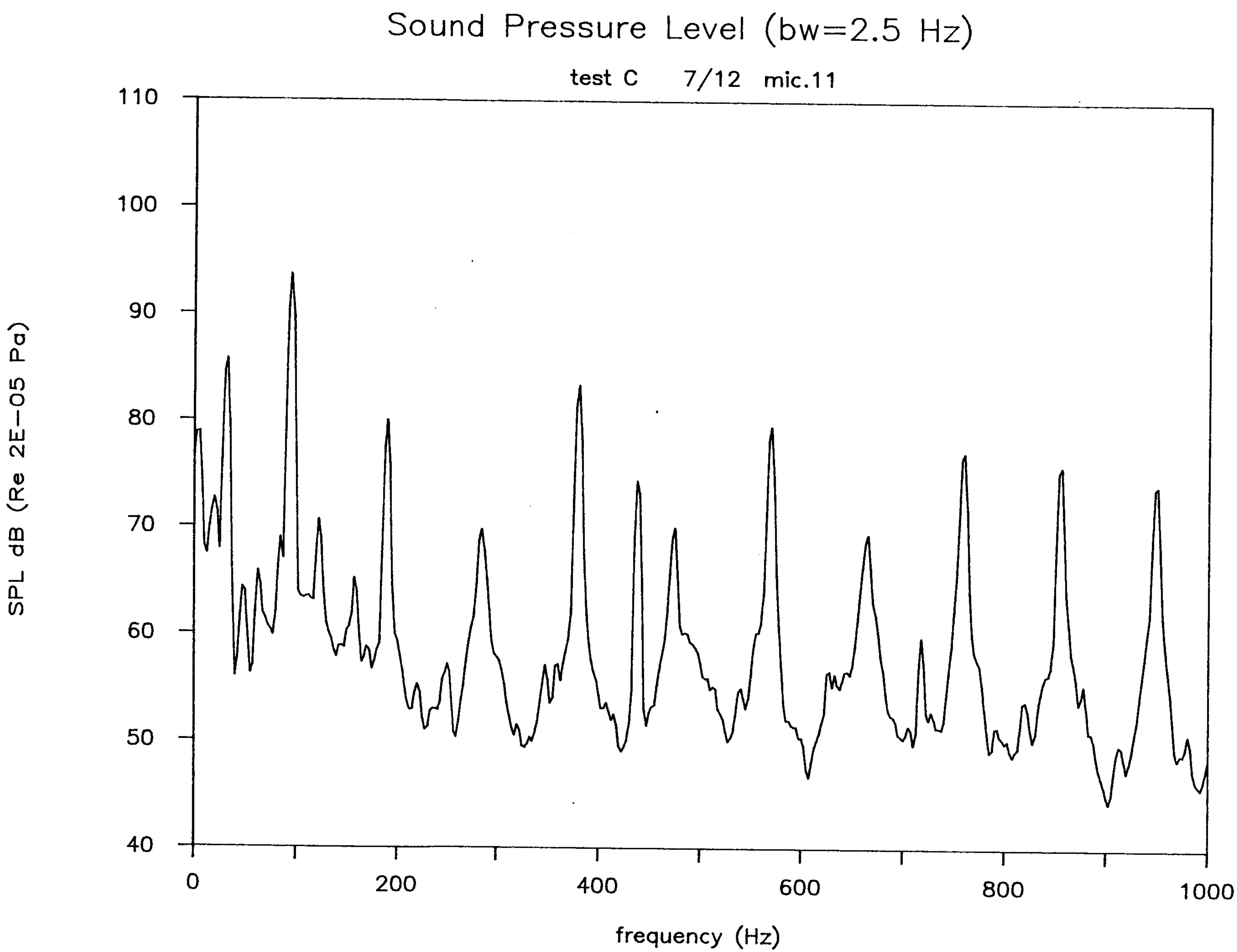

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.6
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

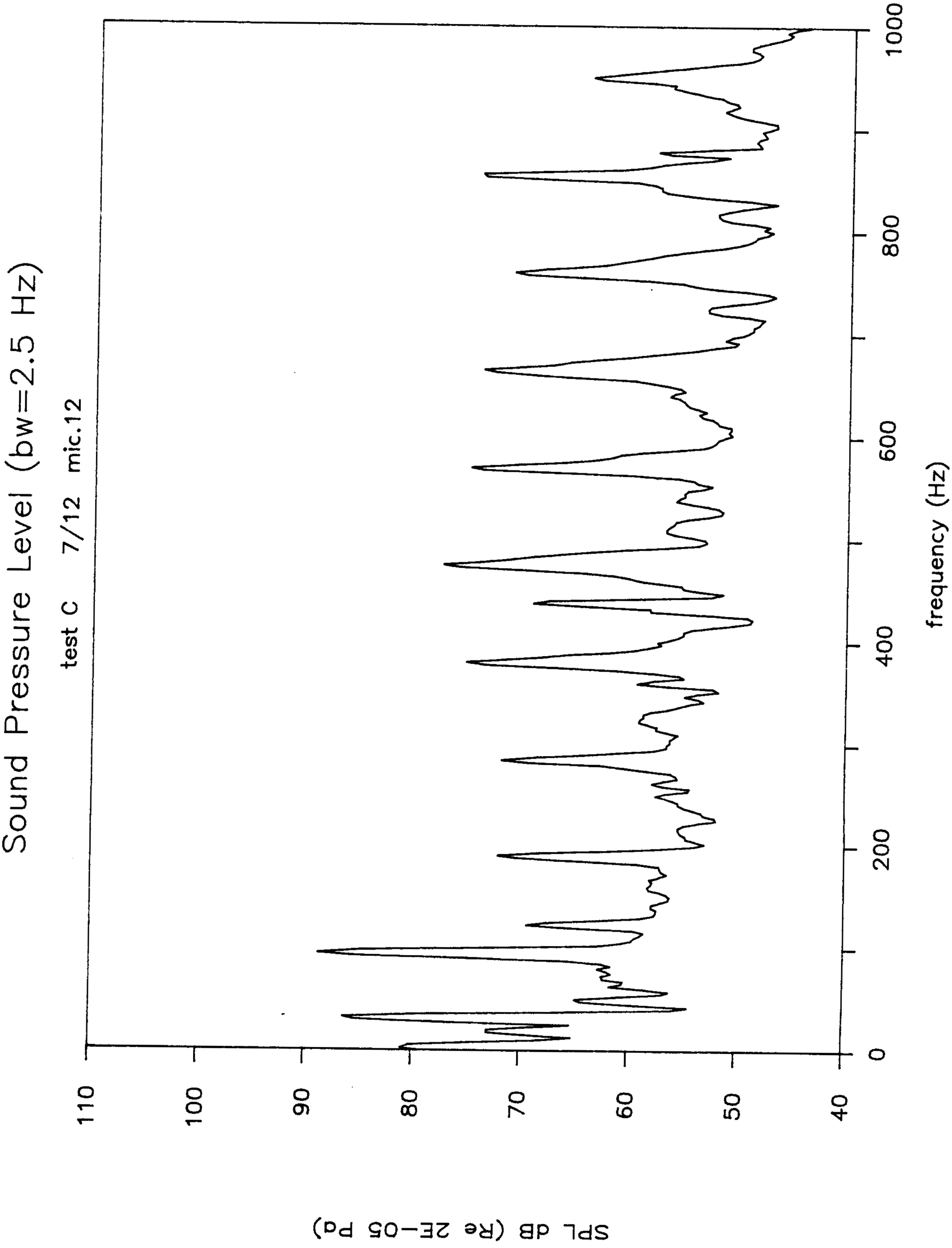

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.7
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

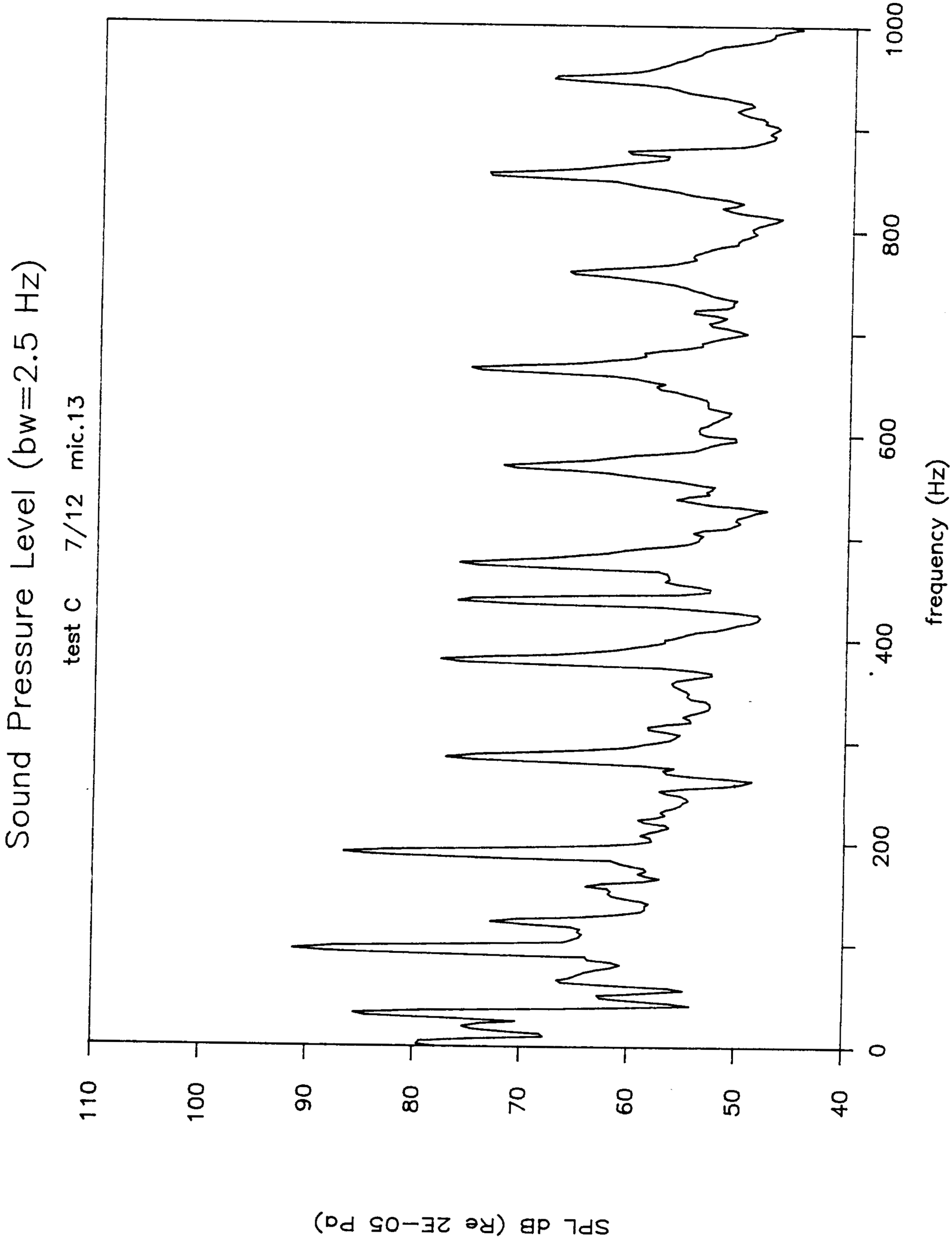

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.8
SPL dB (Re 2E-05 Pa)
frequency (Hz)
0
200
400
600
800
1000
40
50
60
70
80
90
100
110

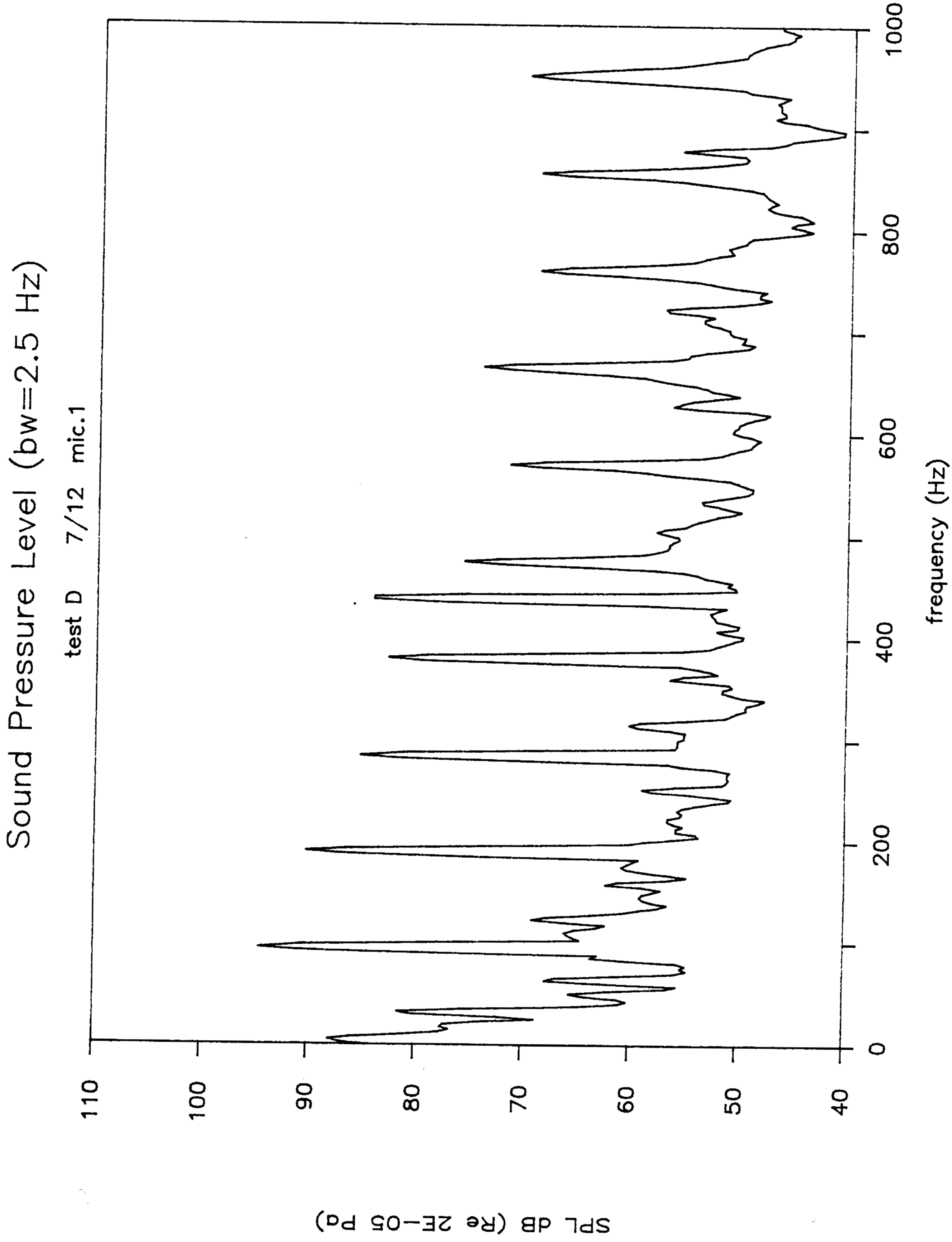

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.9
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

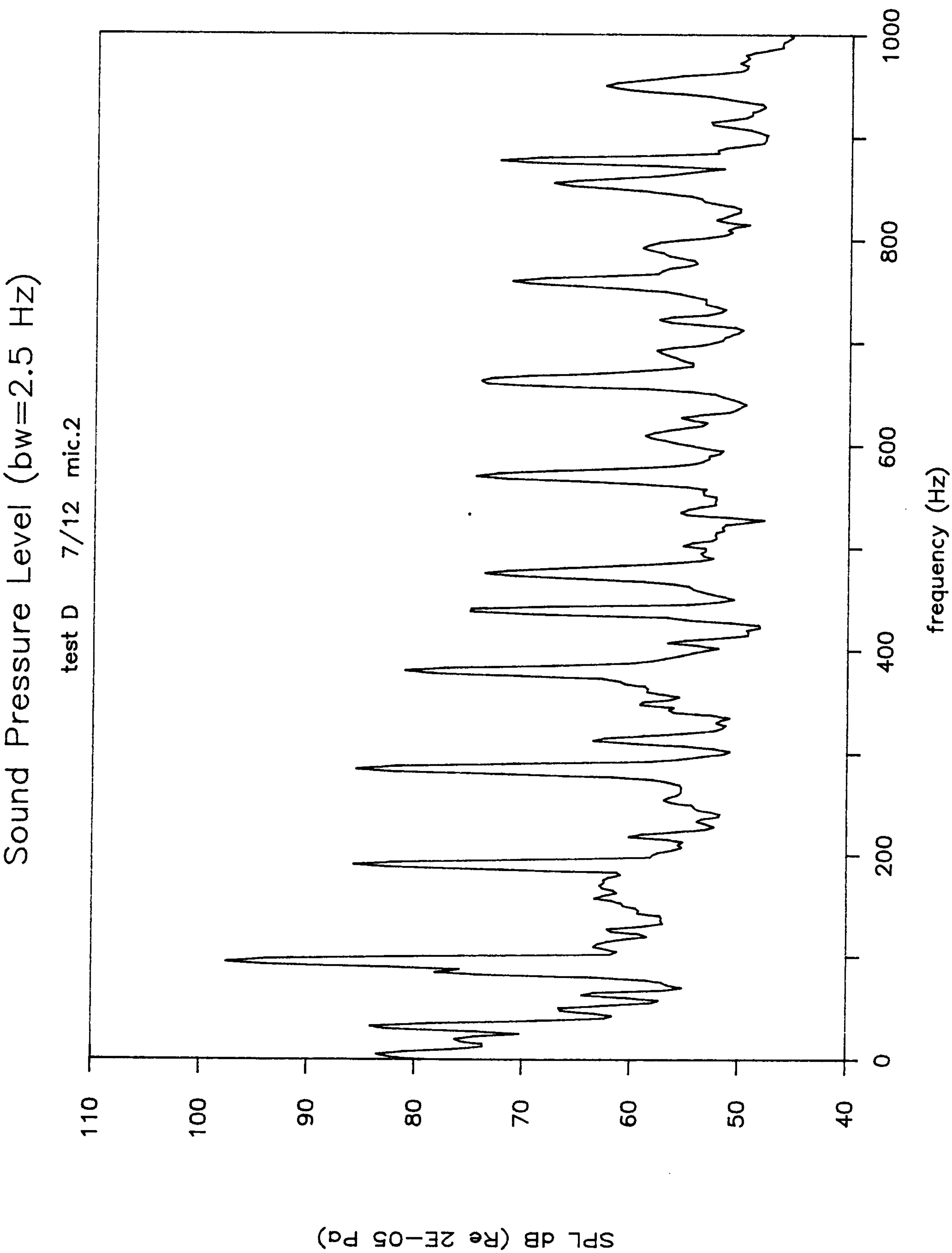

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.10
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

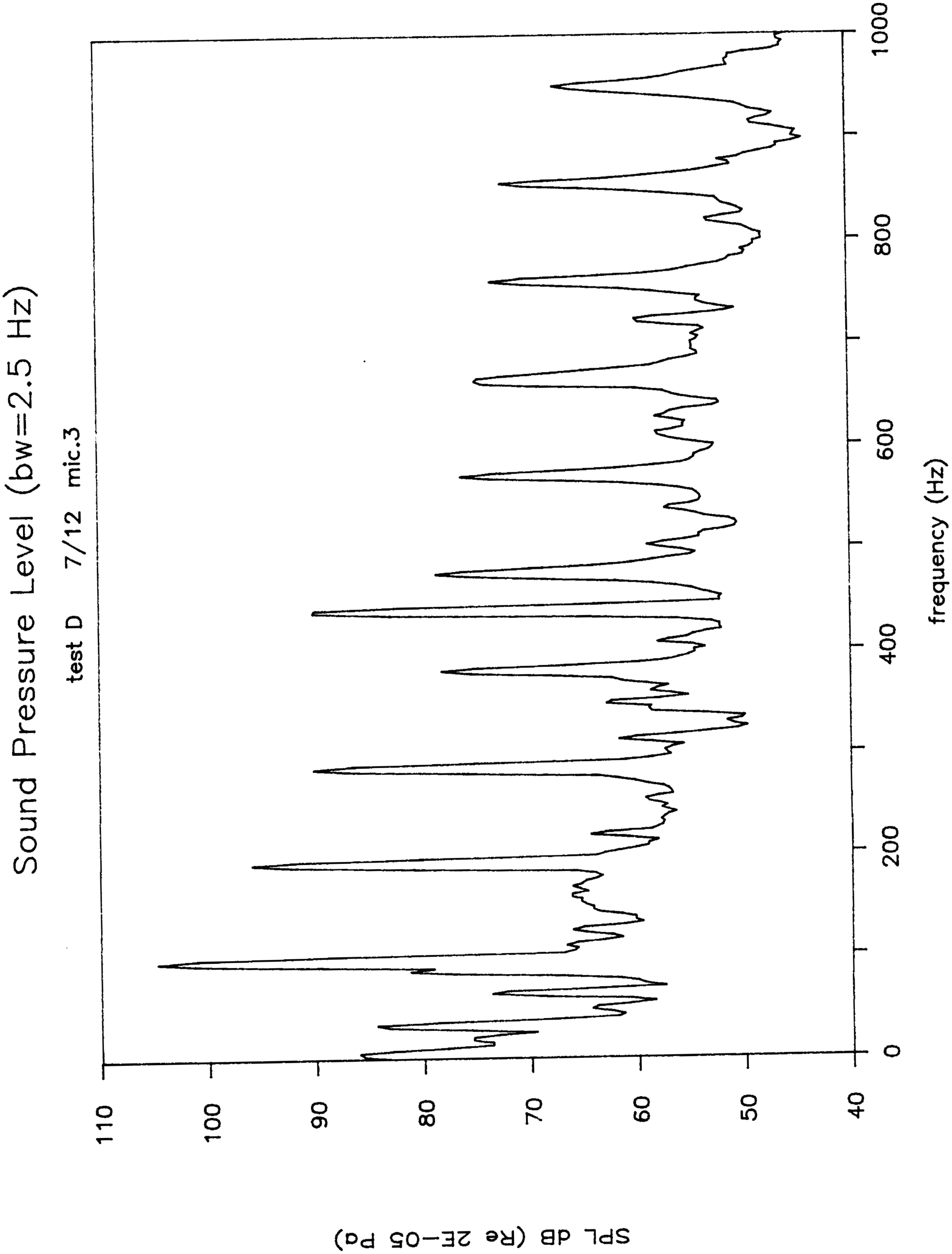

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.11
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

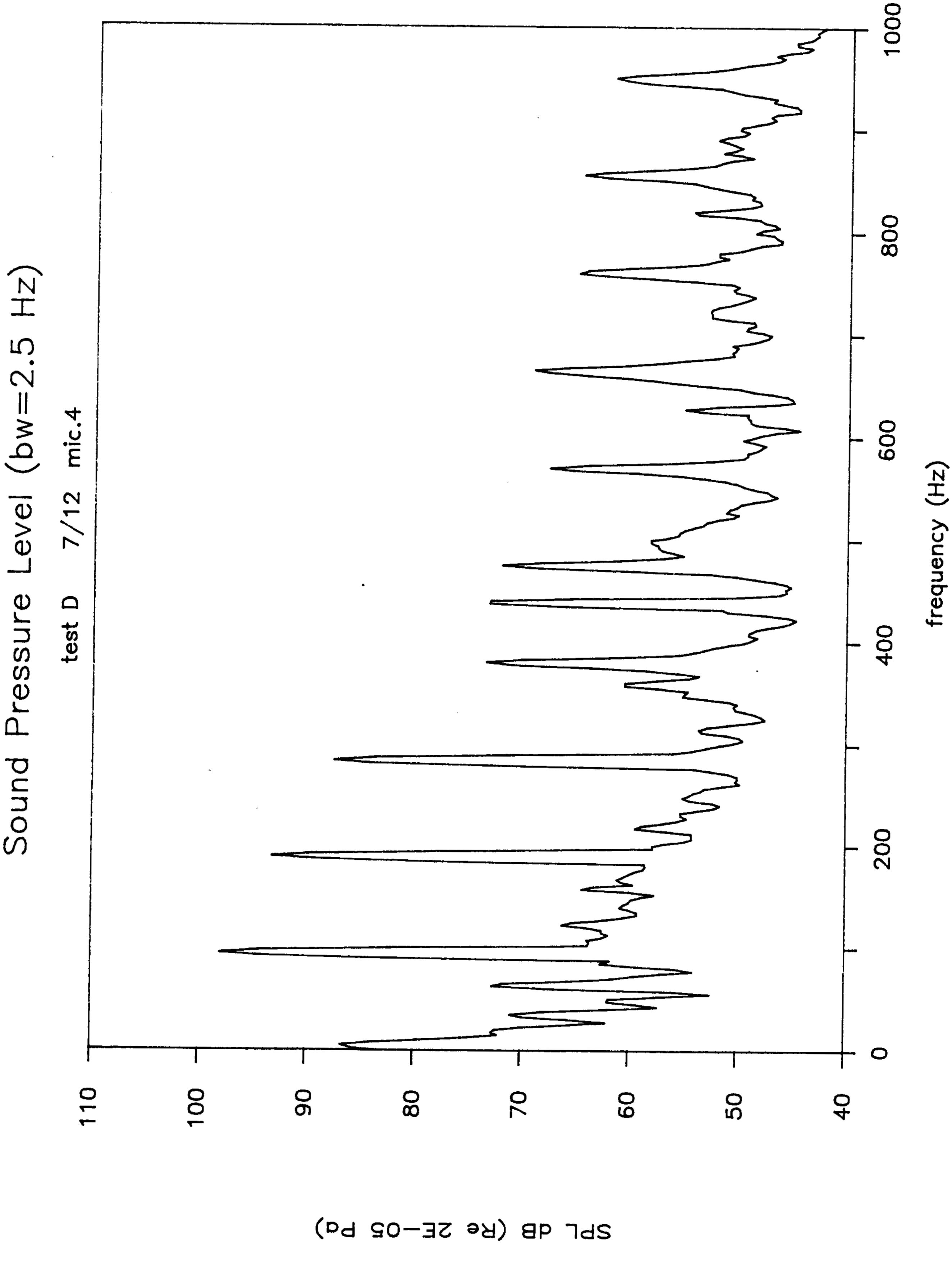

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.12
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

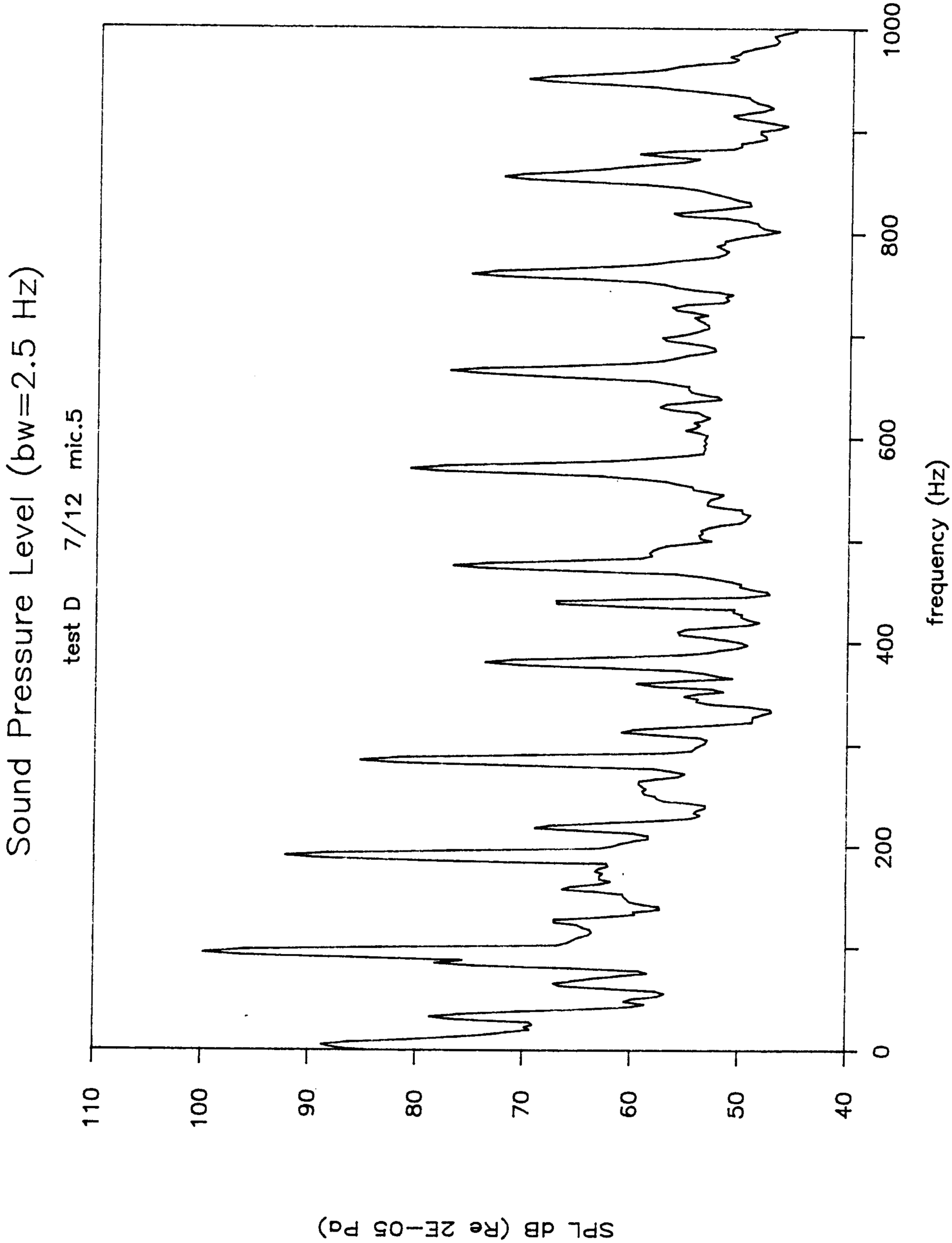

Sound Pressure Level (bw=2.5 Hz)
test C 7/12 mic.13
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

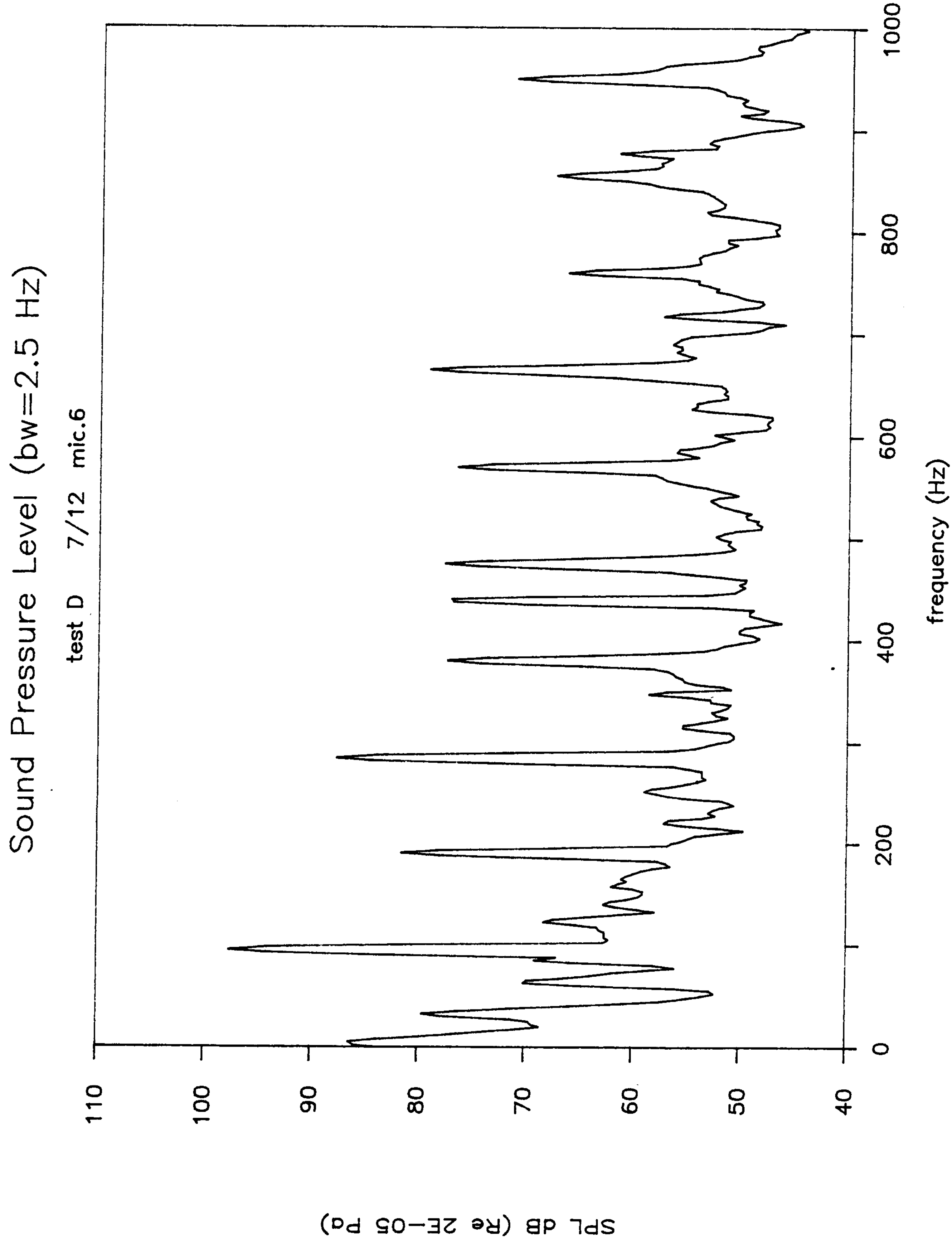

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.1
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

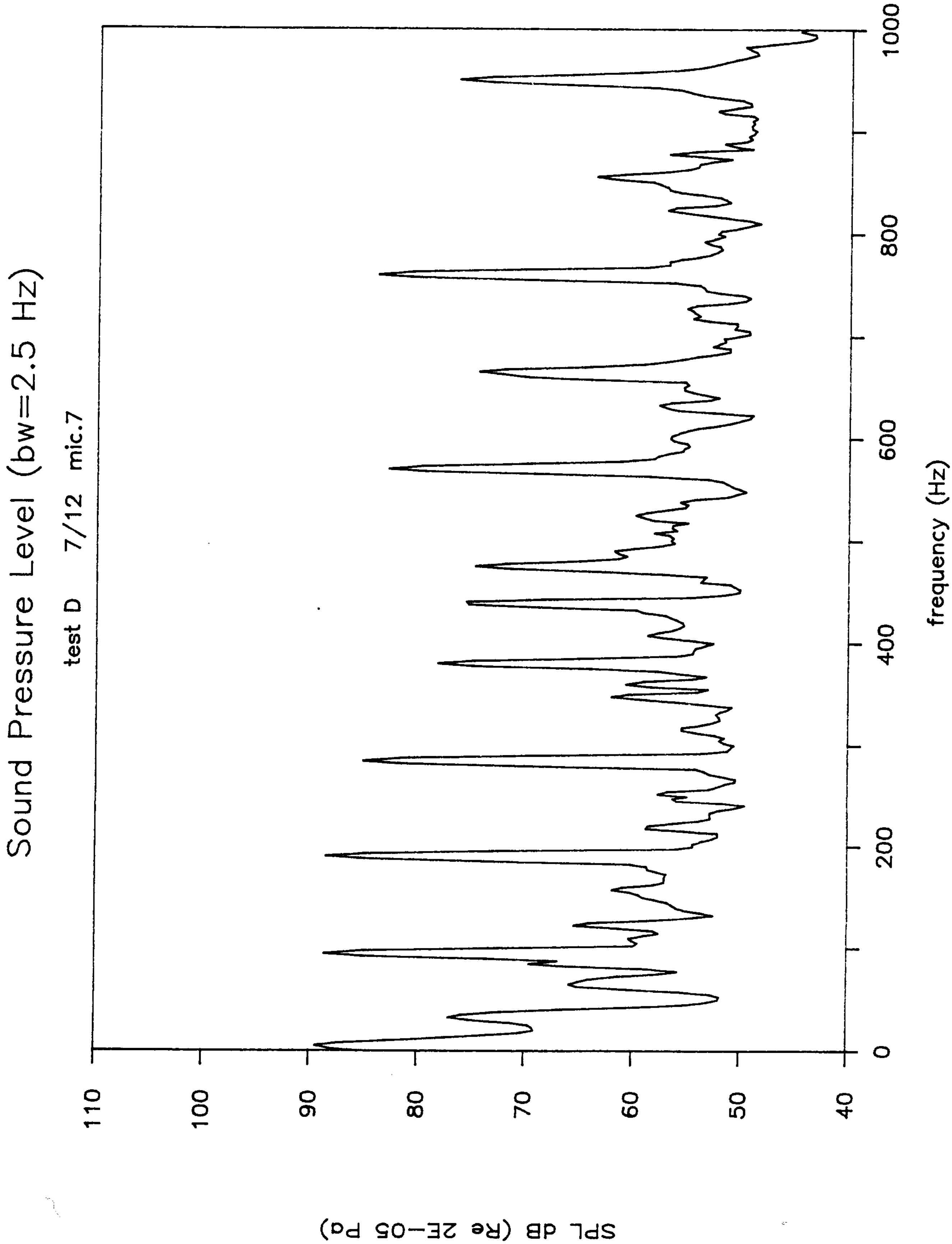

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.2
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000


Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.3
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

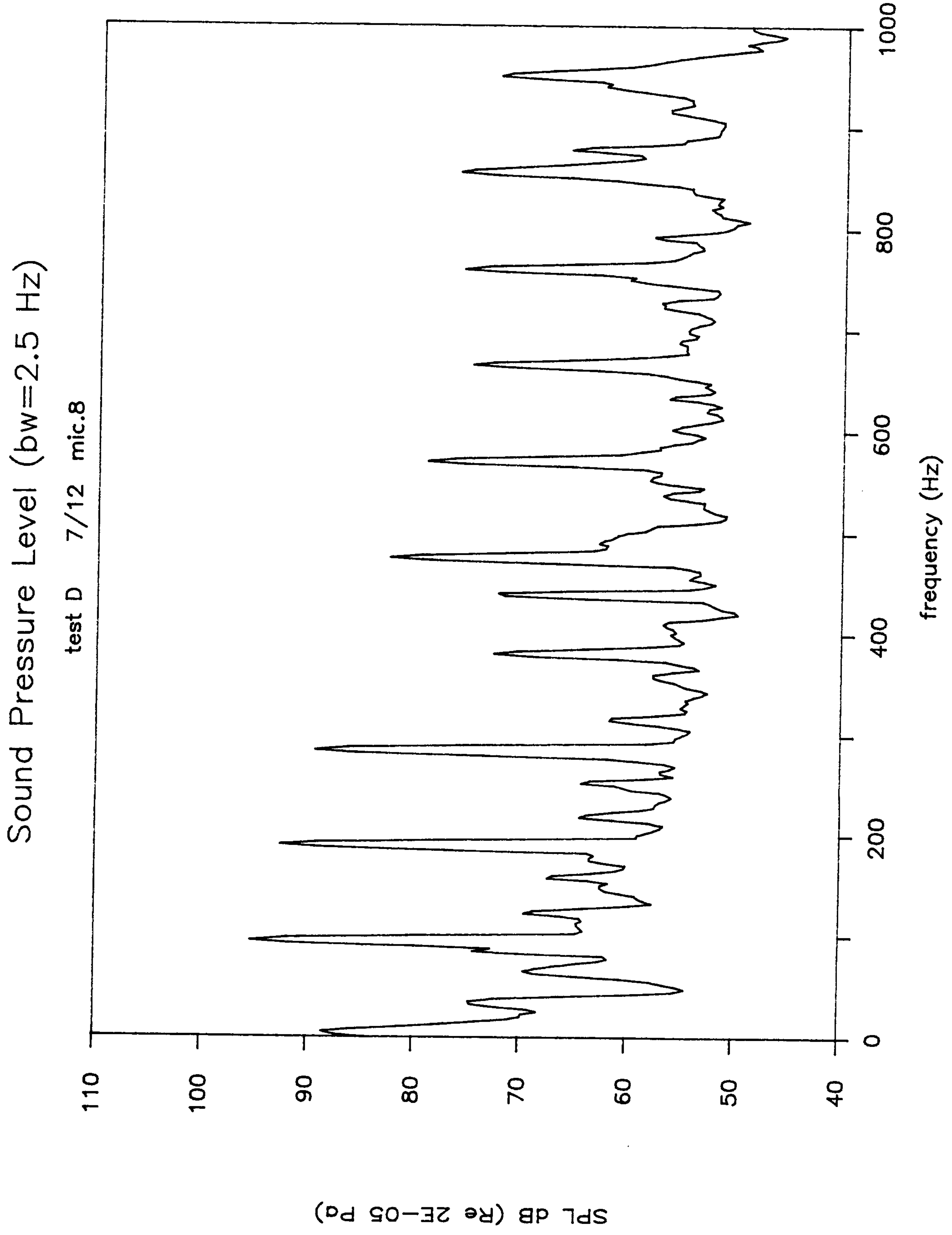

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.4
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

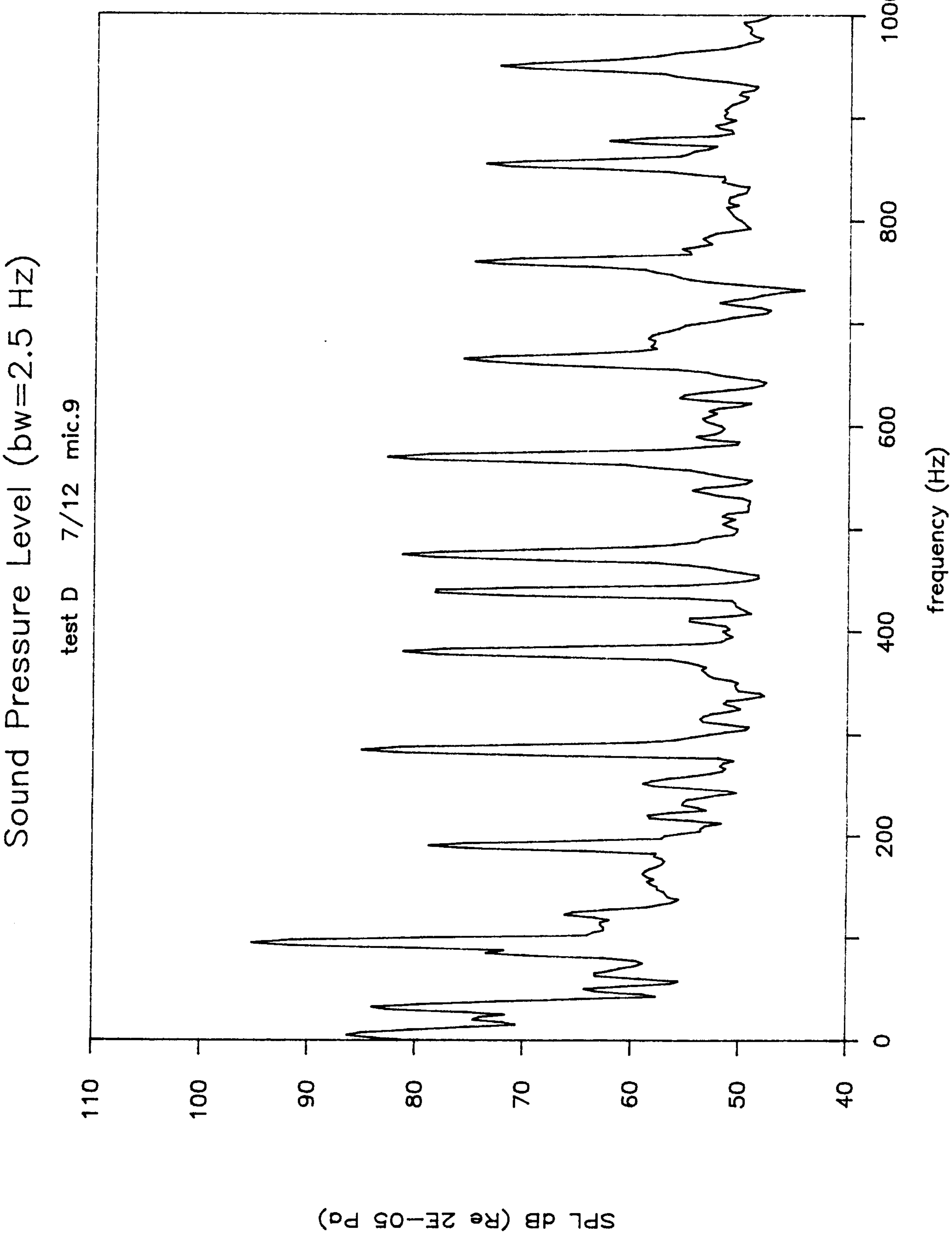

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.5
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

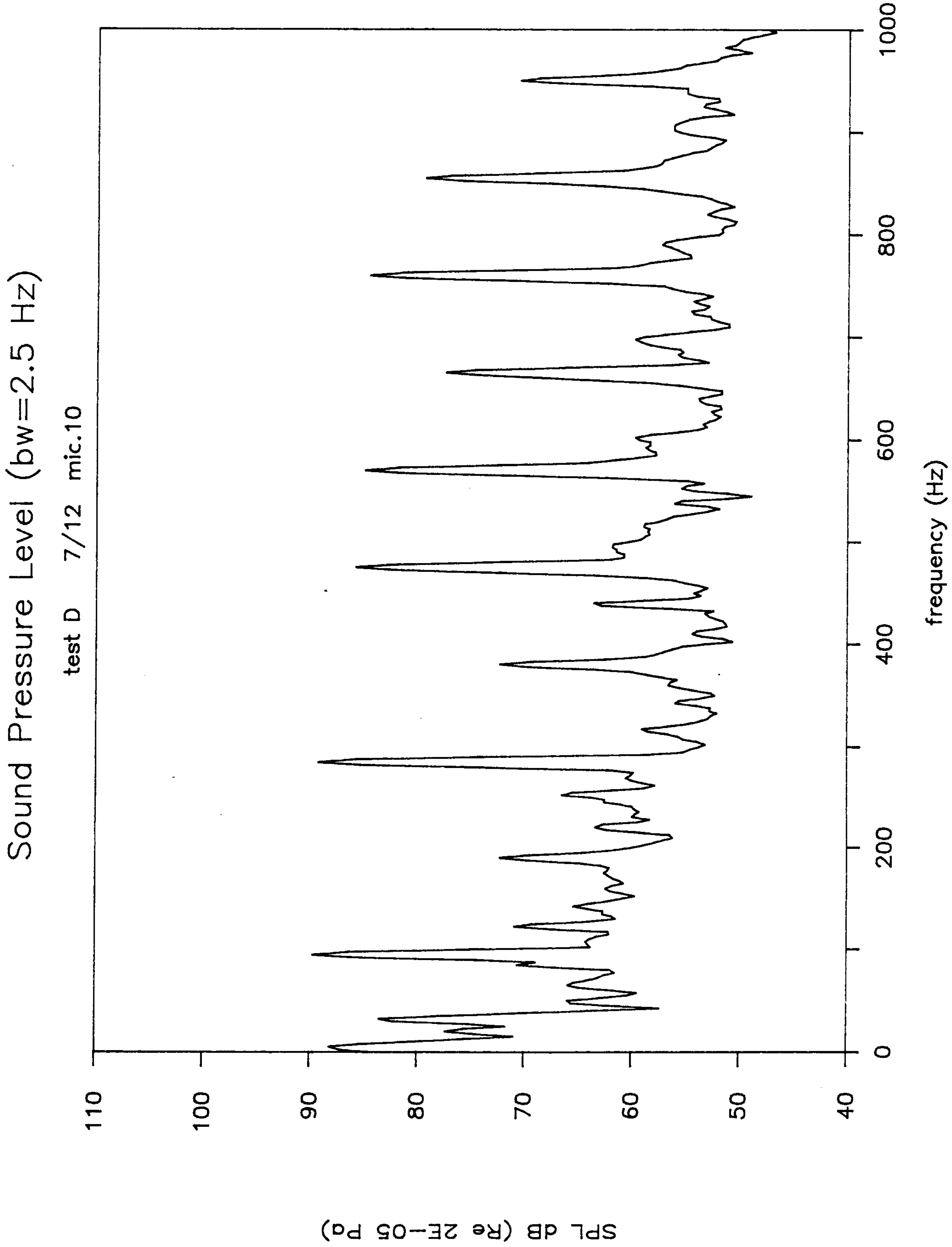

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.6
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

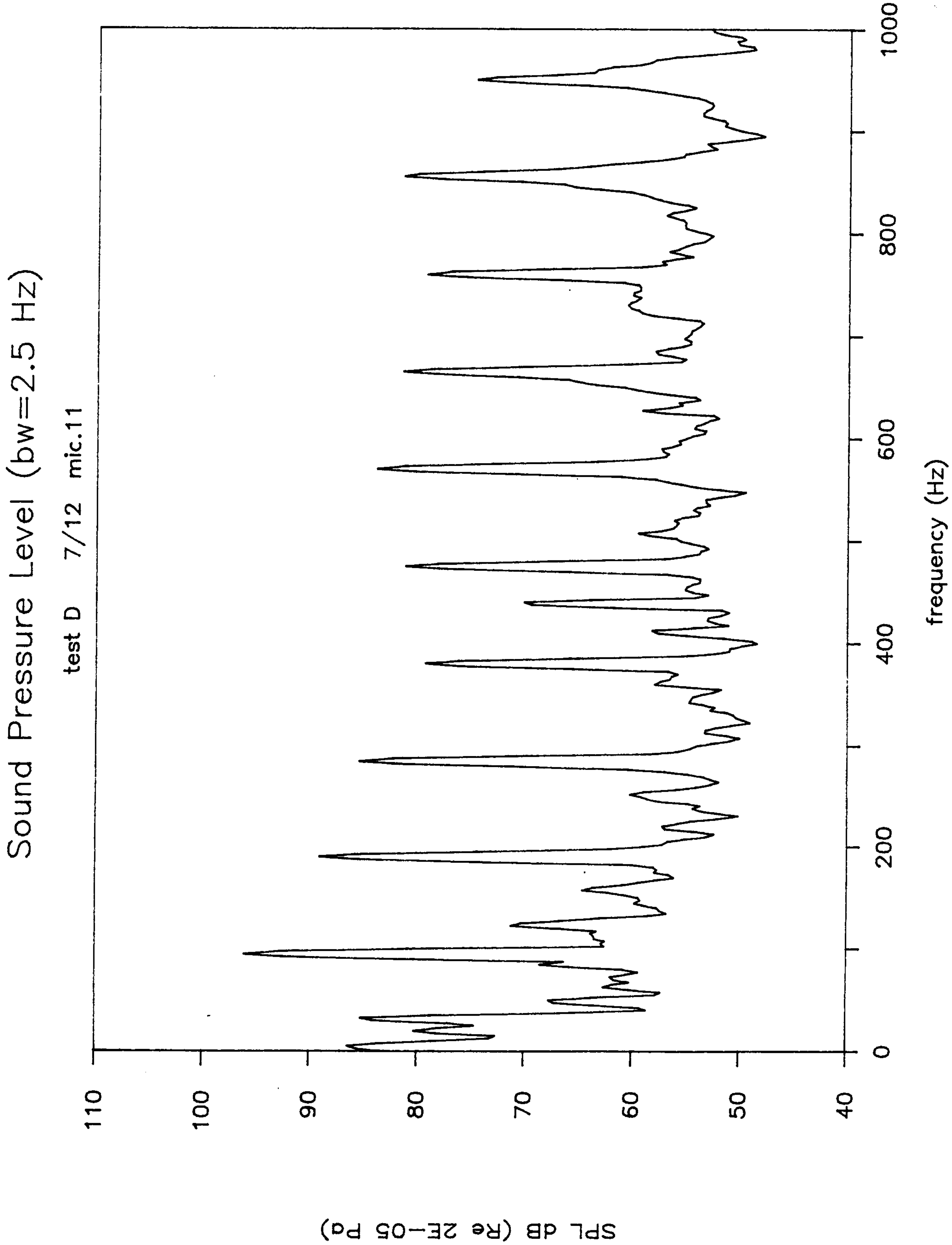


Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.7
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
frequency (Hz)
0
200
400
600
800
1000

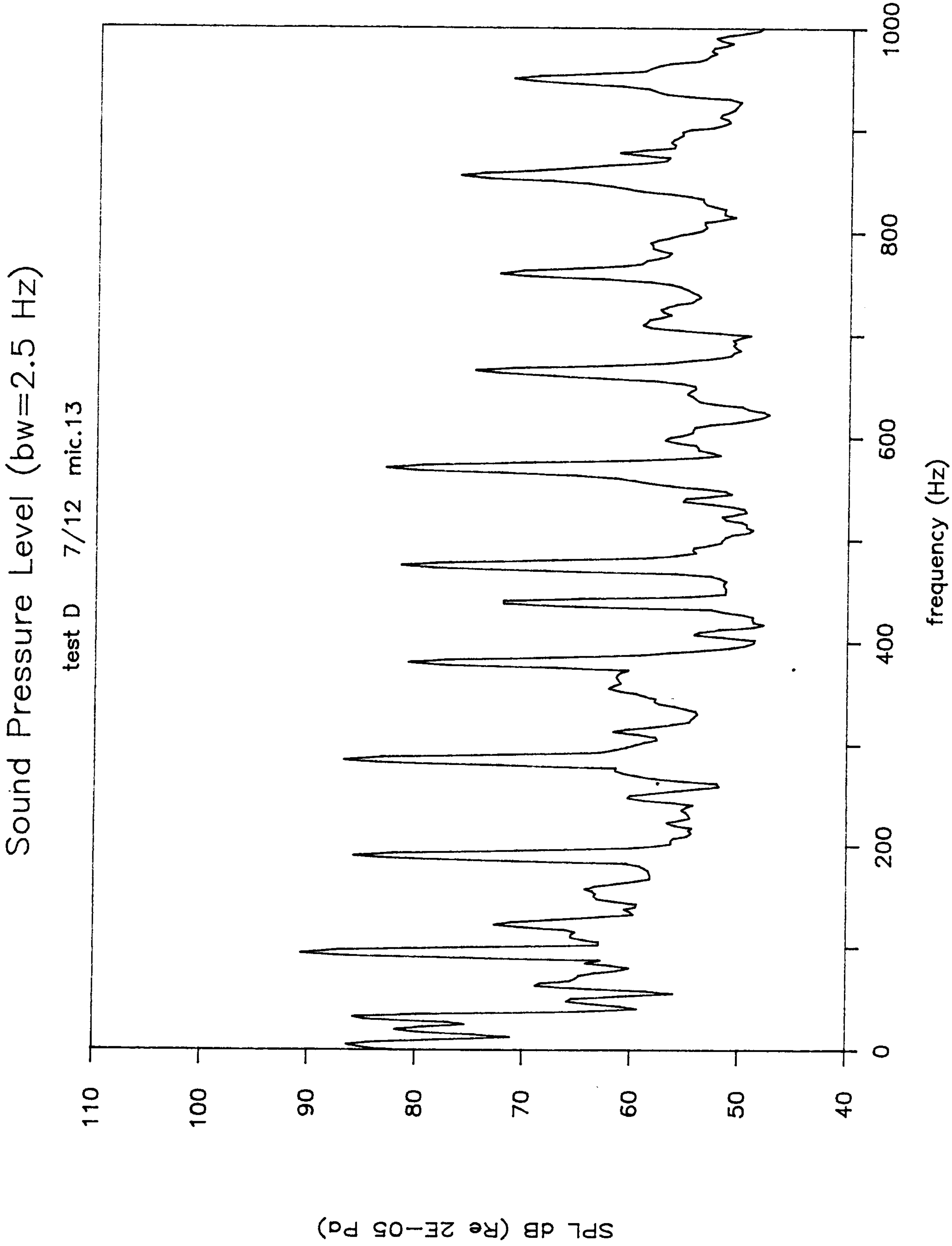

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.8
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

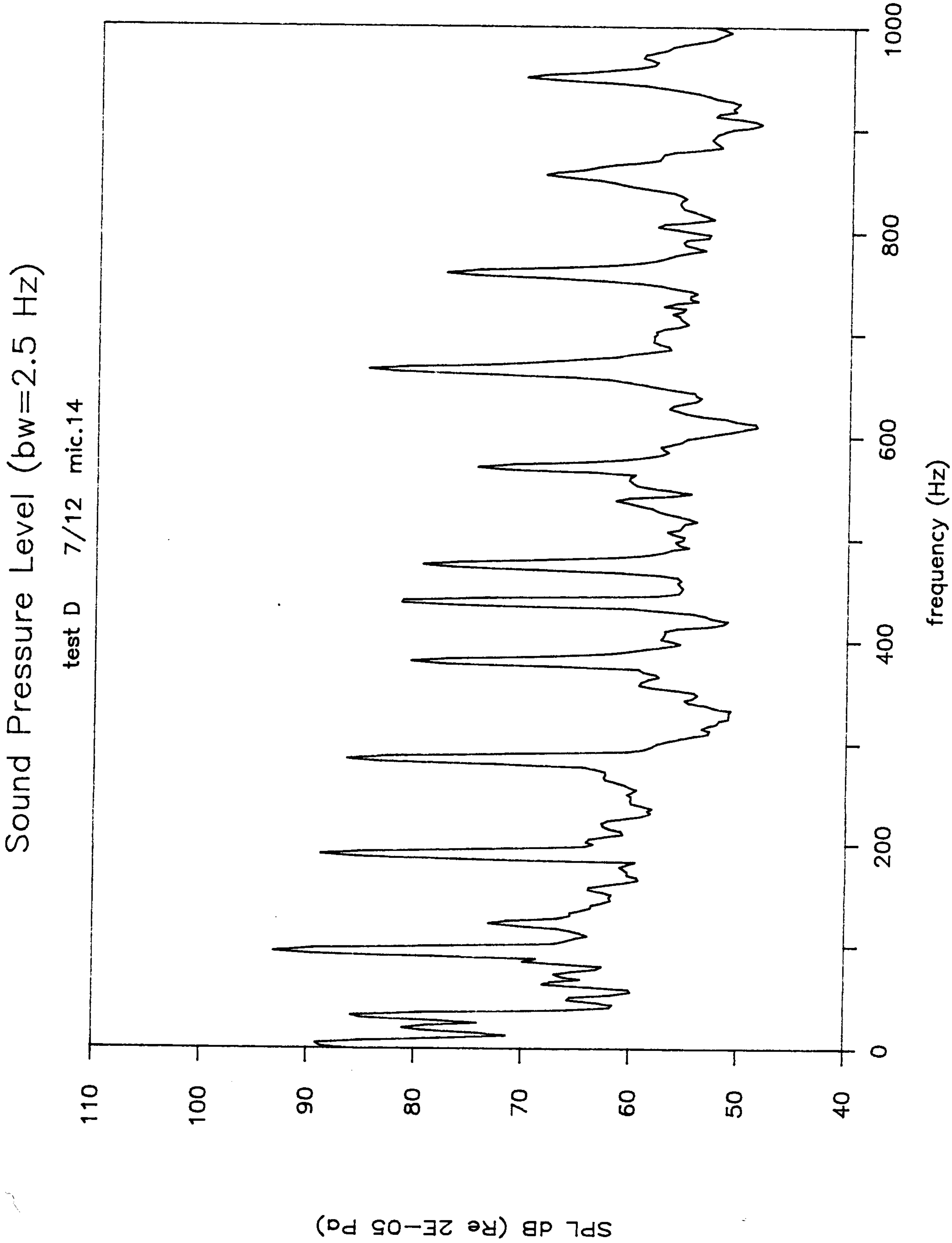

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.9
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)


Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.10
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

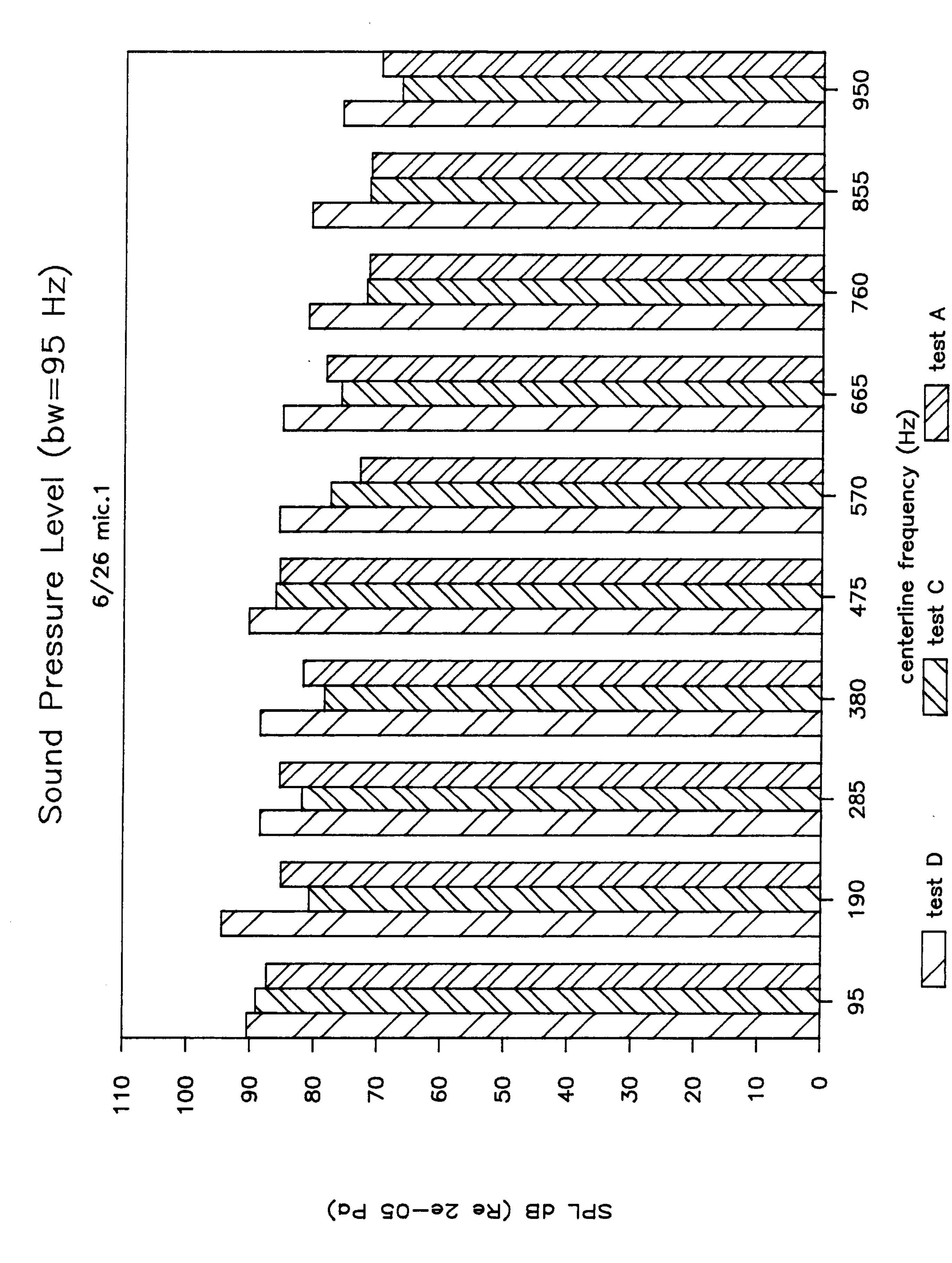


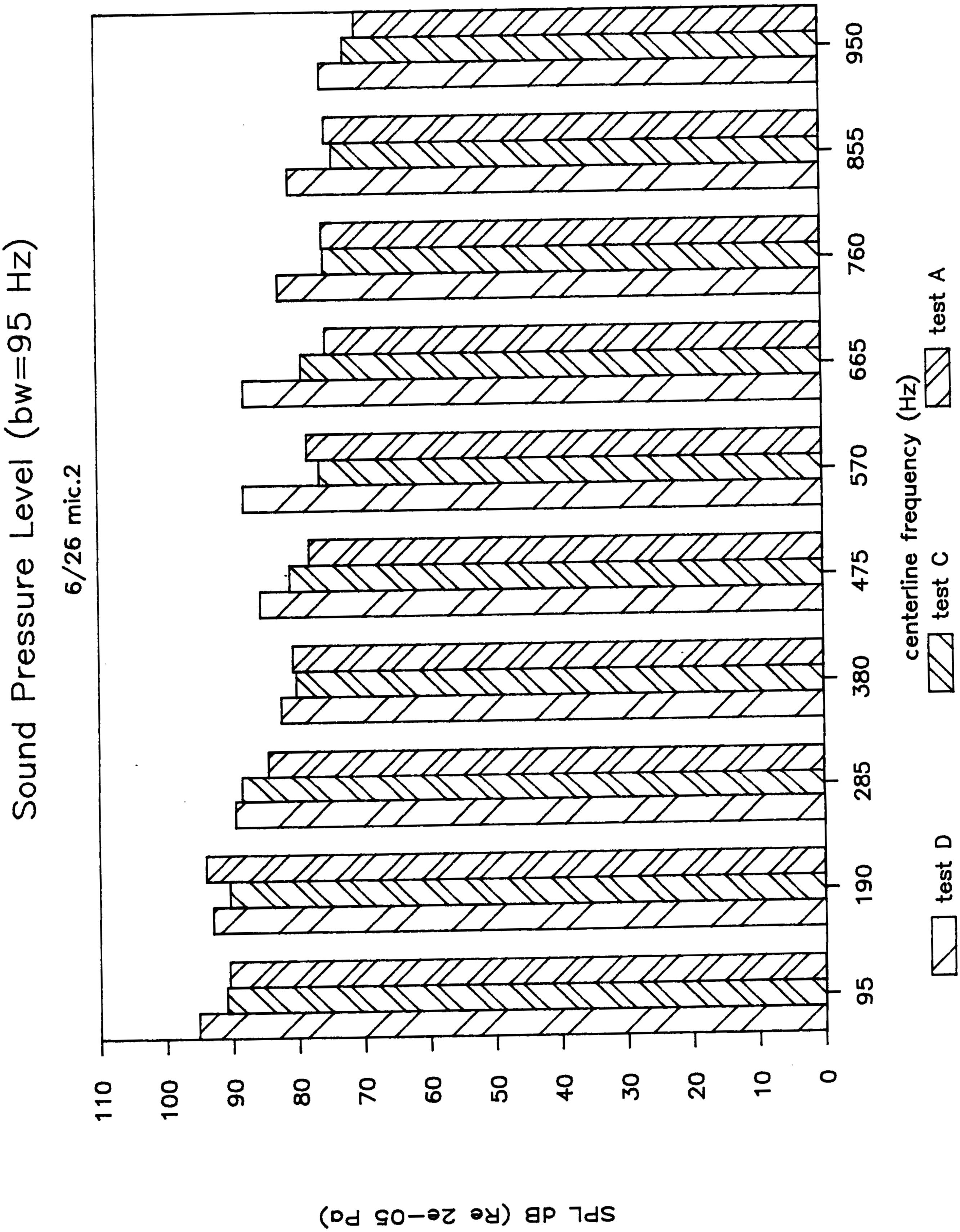
Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.11
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

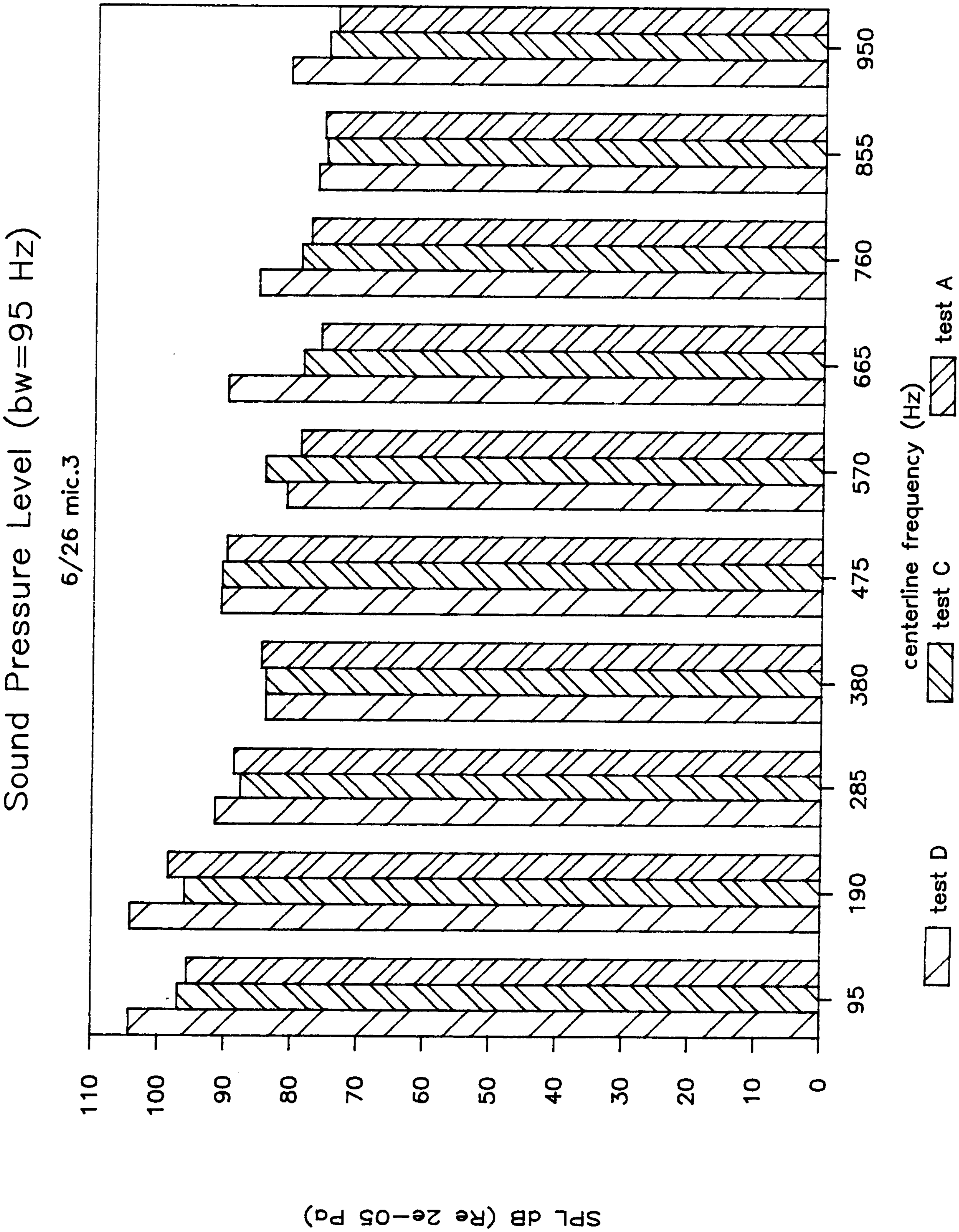

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.13
SPL dB (Re 2E-05 Pa)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000
frequency (Hz)

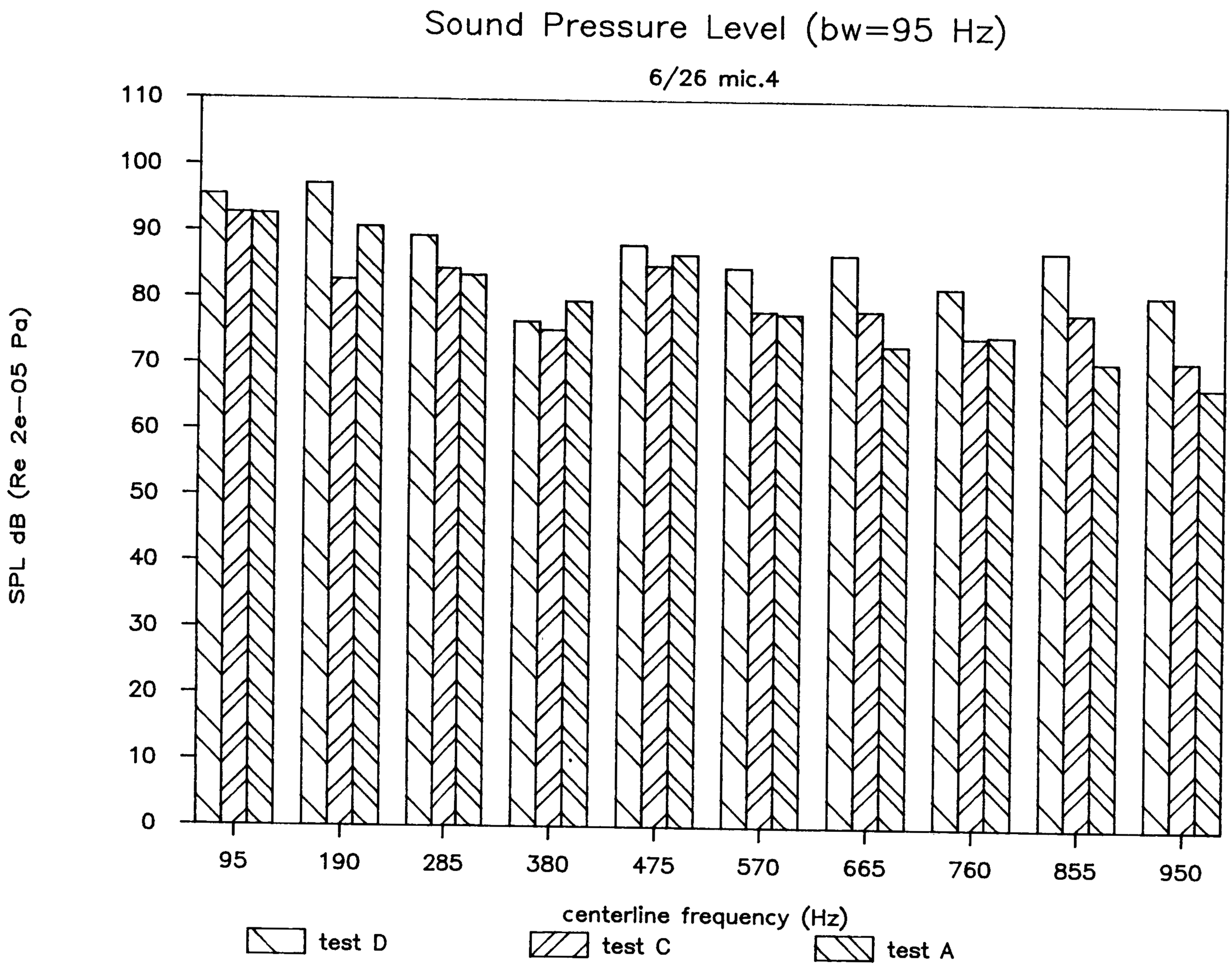

Sound Pressure Level (bw=2.5 Hz)
test D 7/12 mic.14
SPL dB (Re 2E-05 Pa)
frequency (Hz)
110
100
90
80
70
60
50
40
0
200
400
600
800
1000

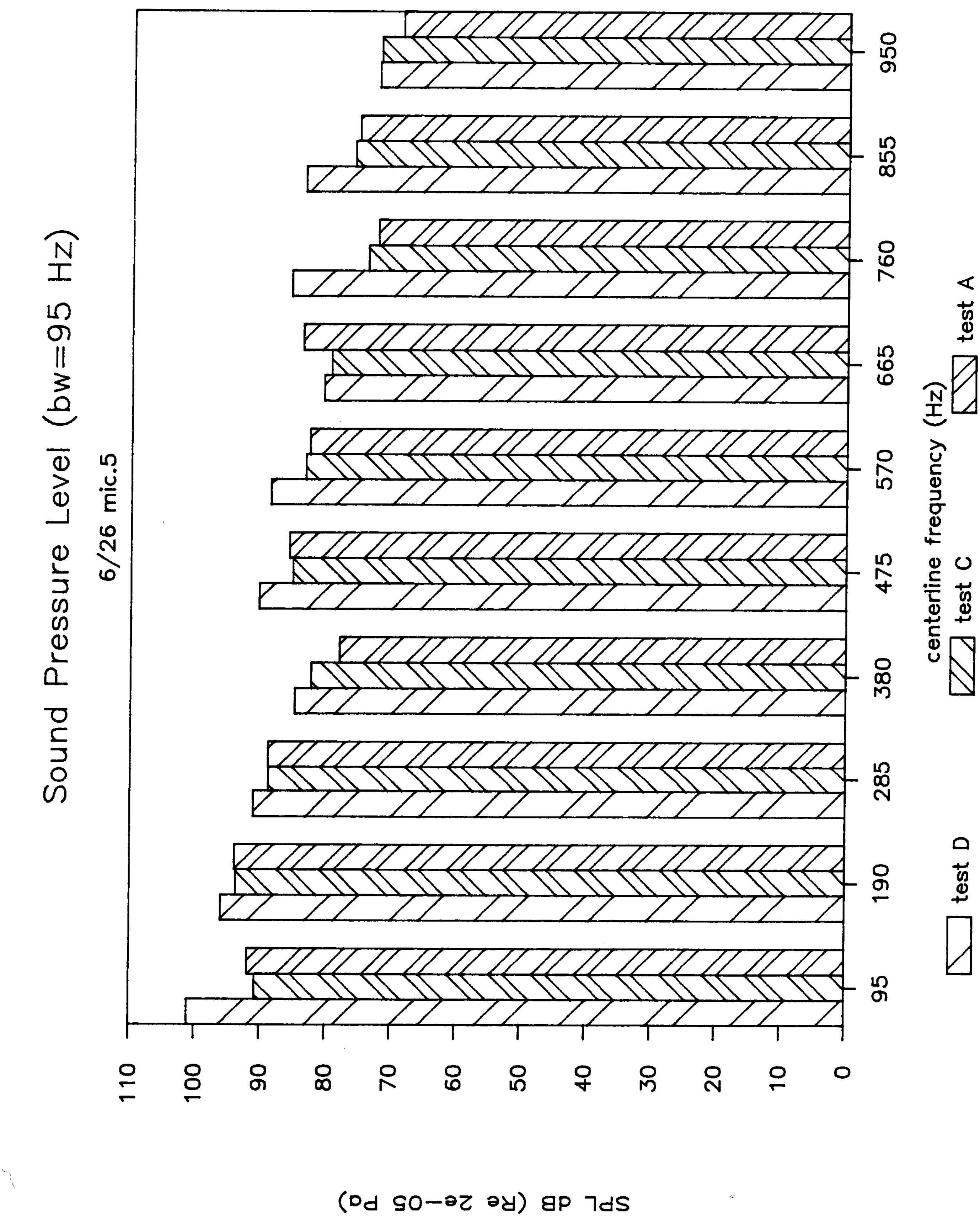
APPENDIX B: WIDEBAND SPECTRA

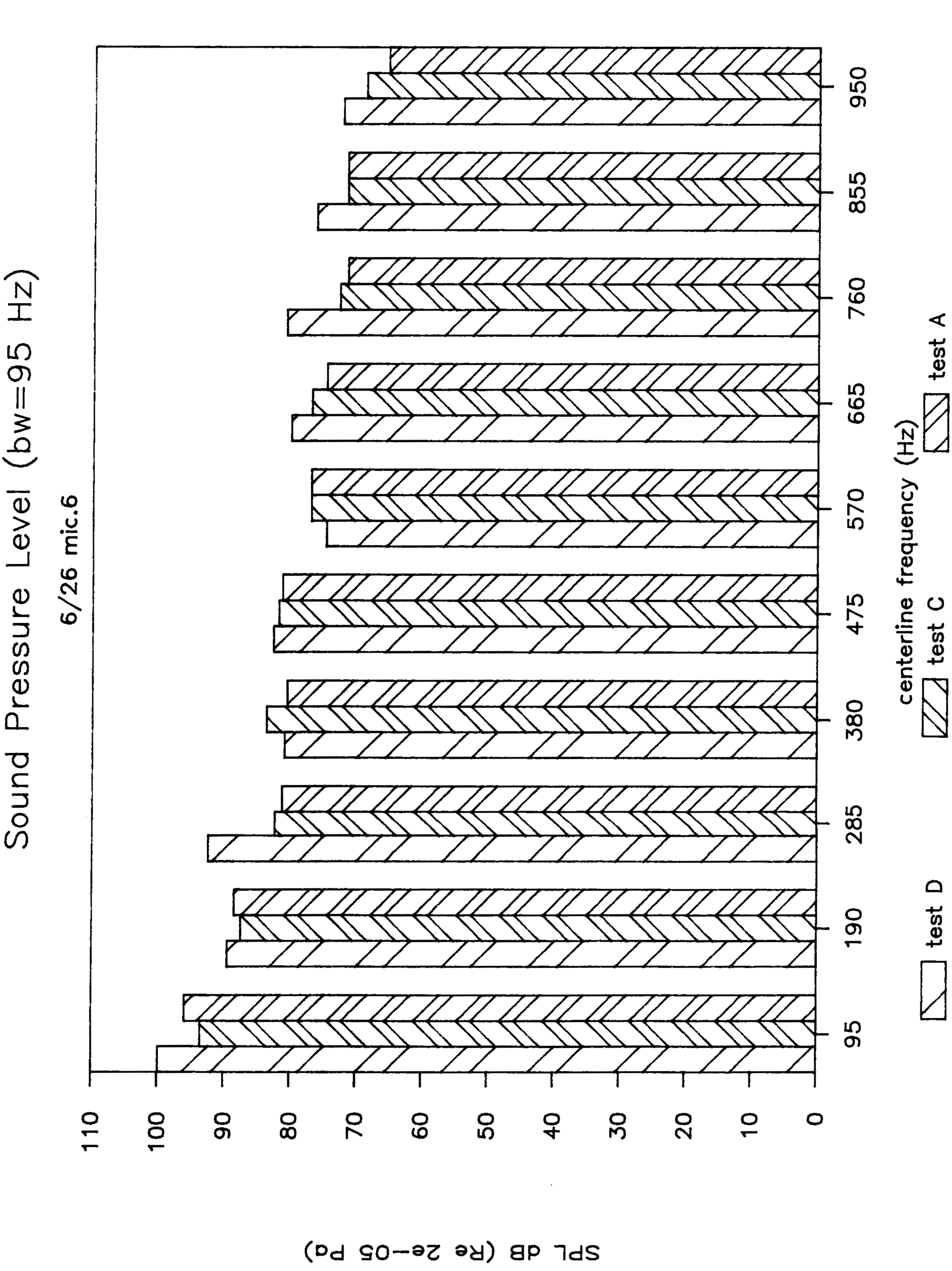

Sound Pressure Level (bw=95 Hz)
6/26 mic.1
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

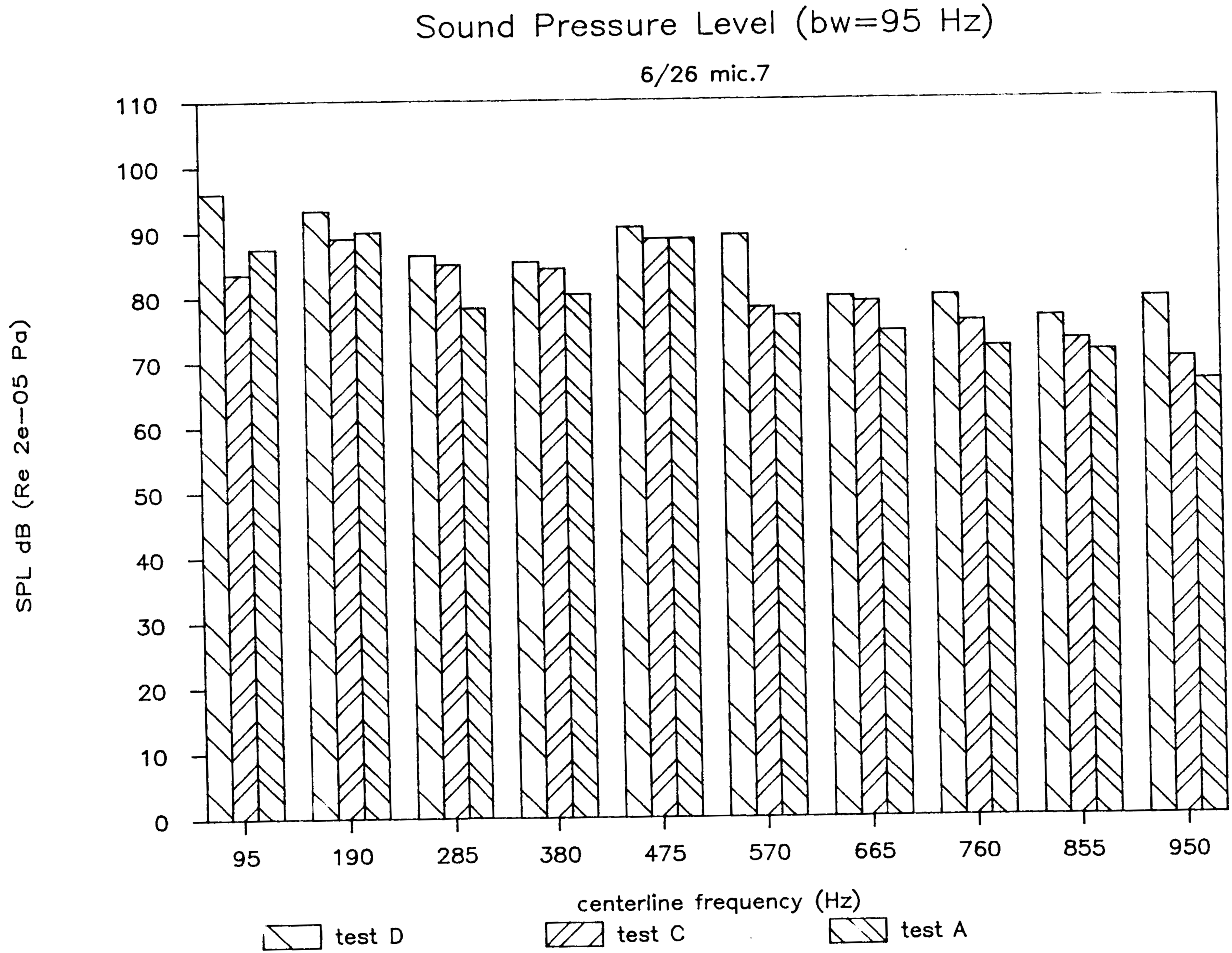

Sound Pressure Level (bw=95 Hz)
6/26 mic.2
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

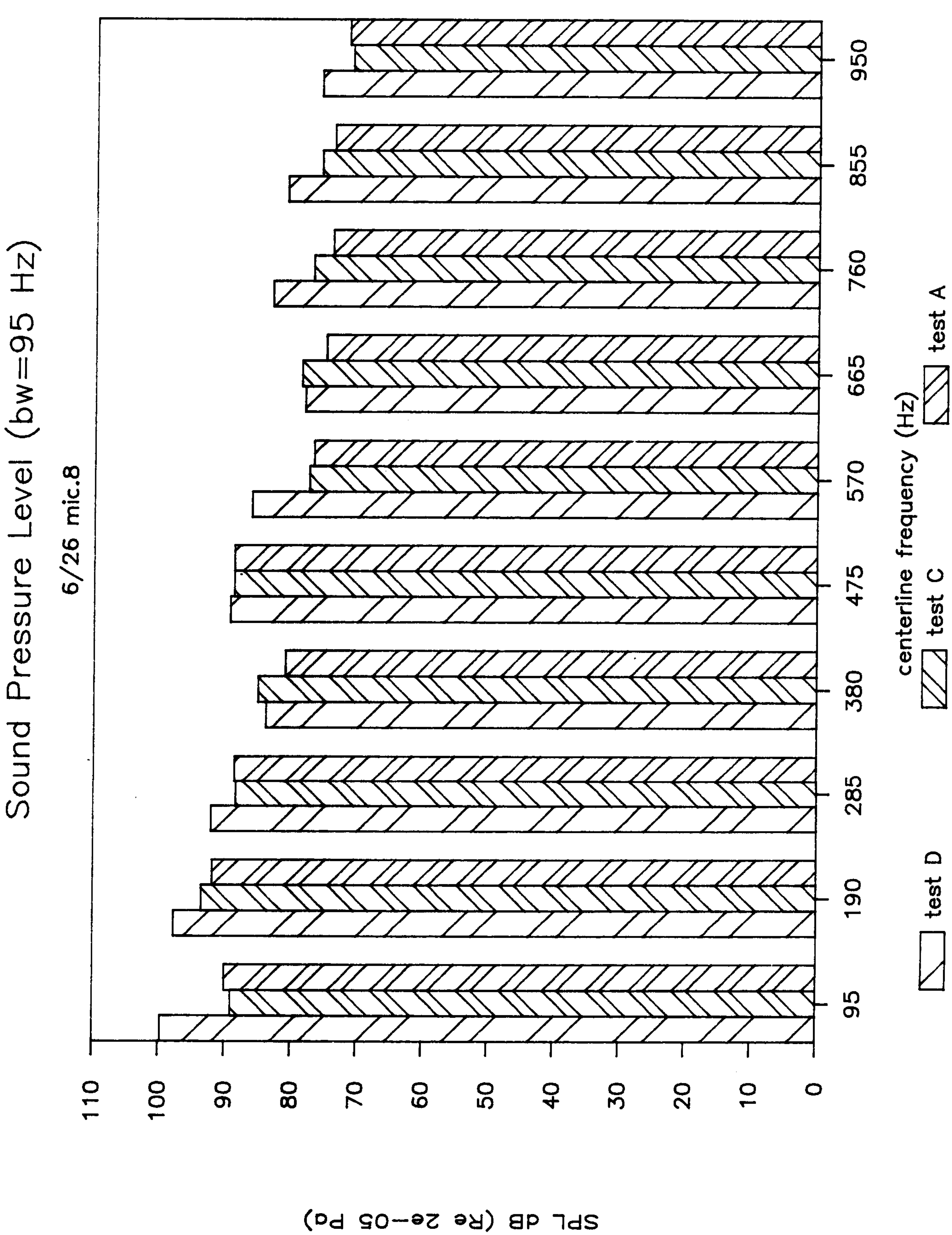

Sound Pressure Level (bw=95 Hz)
6/26 mic.3
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

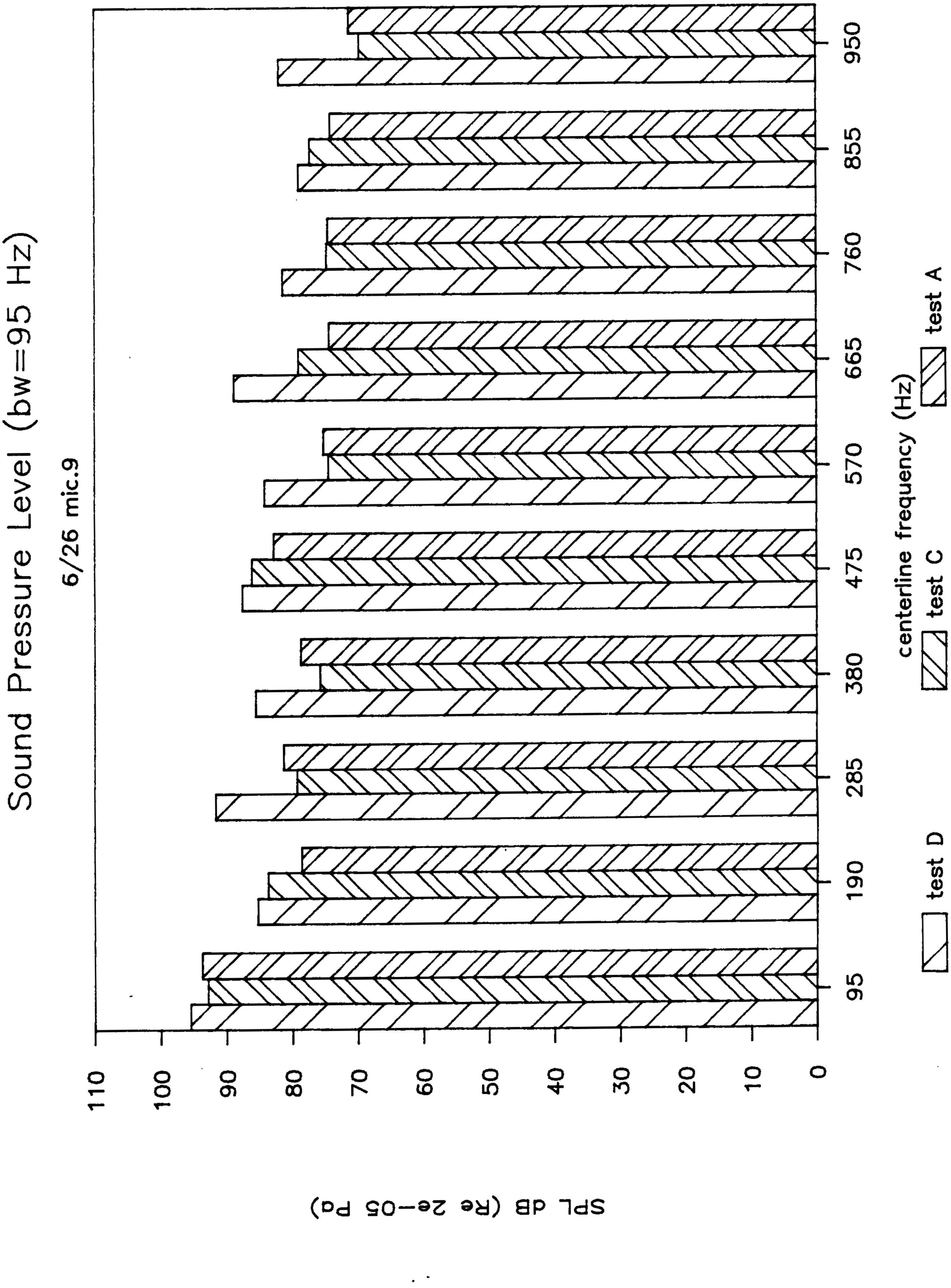

Sound Pressure Level (bw=95 Hz)
6/26 mic.4
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

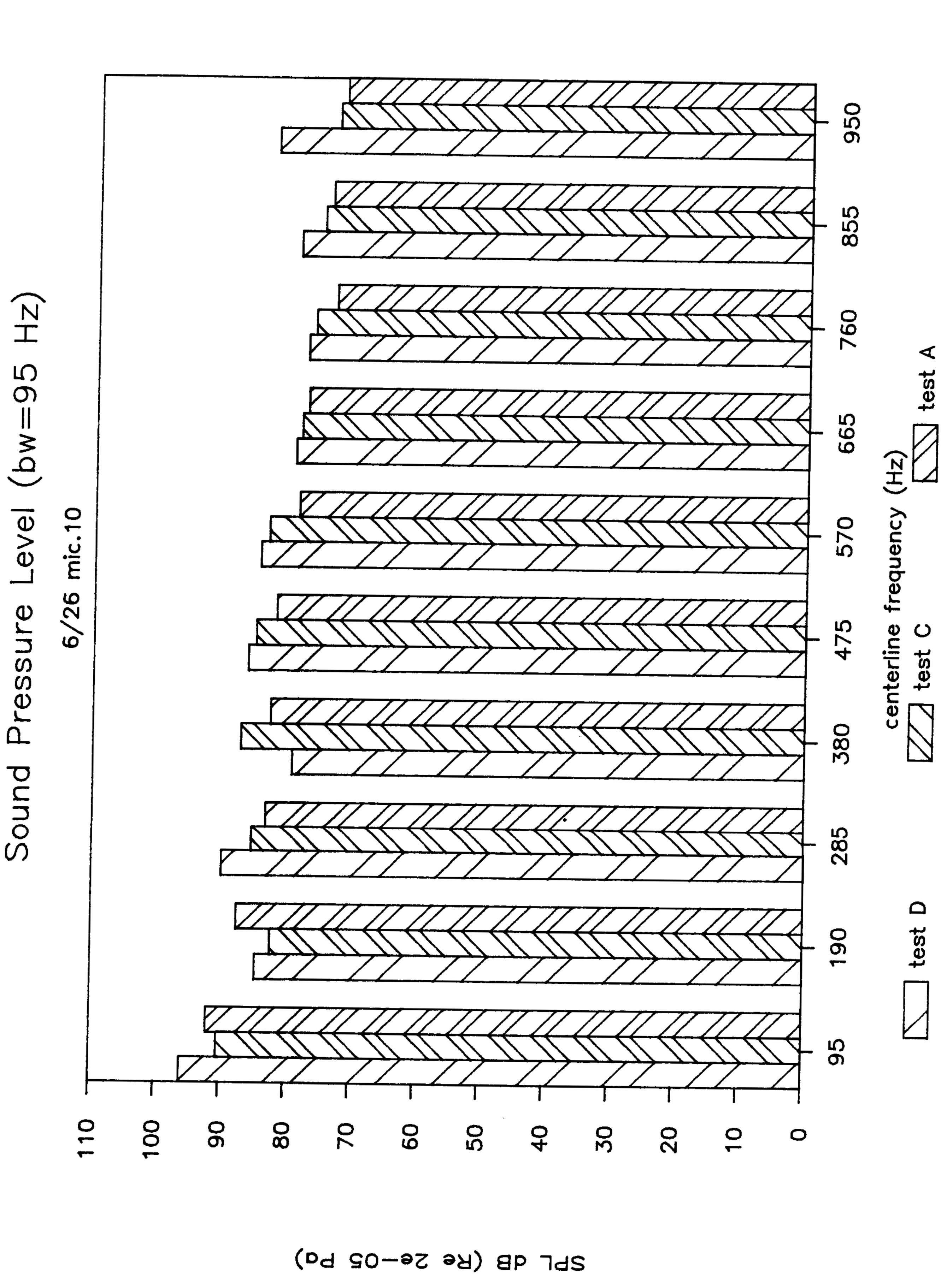

Sound Pressure Level (bw=95 Hz)
6/26 mic.5
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A


Sound Pressure Level (bw=95 Hz)
6/26 mic.6
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

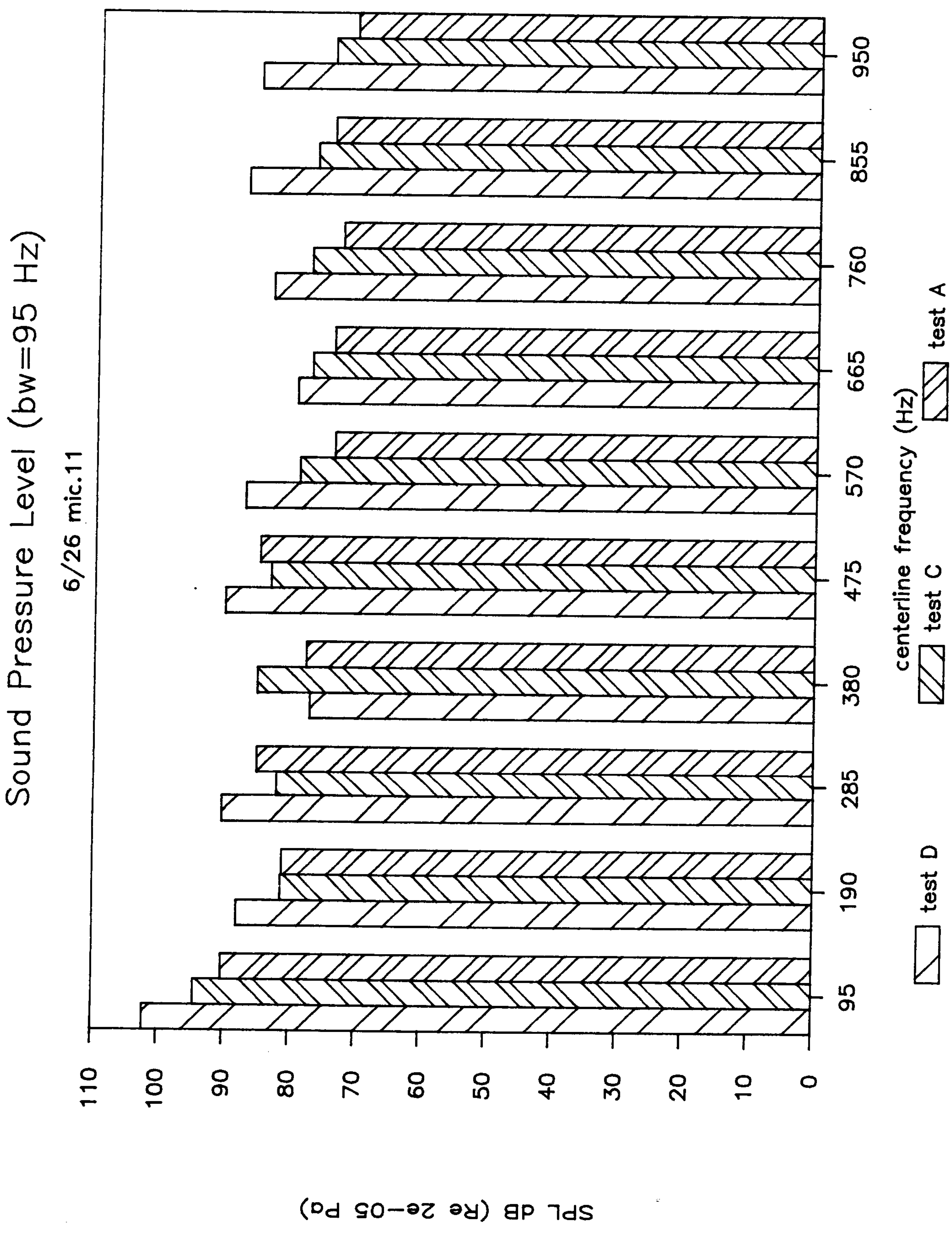

Sound Pressure Level (bw=95 Hz)
6/26 mic.7
SPL dB (Re 2e−05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

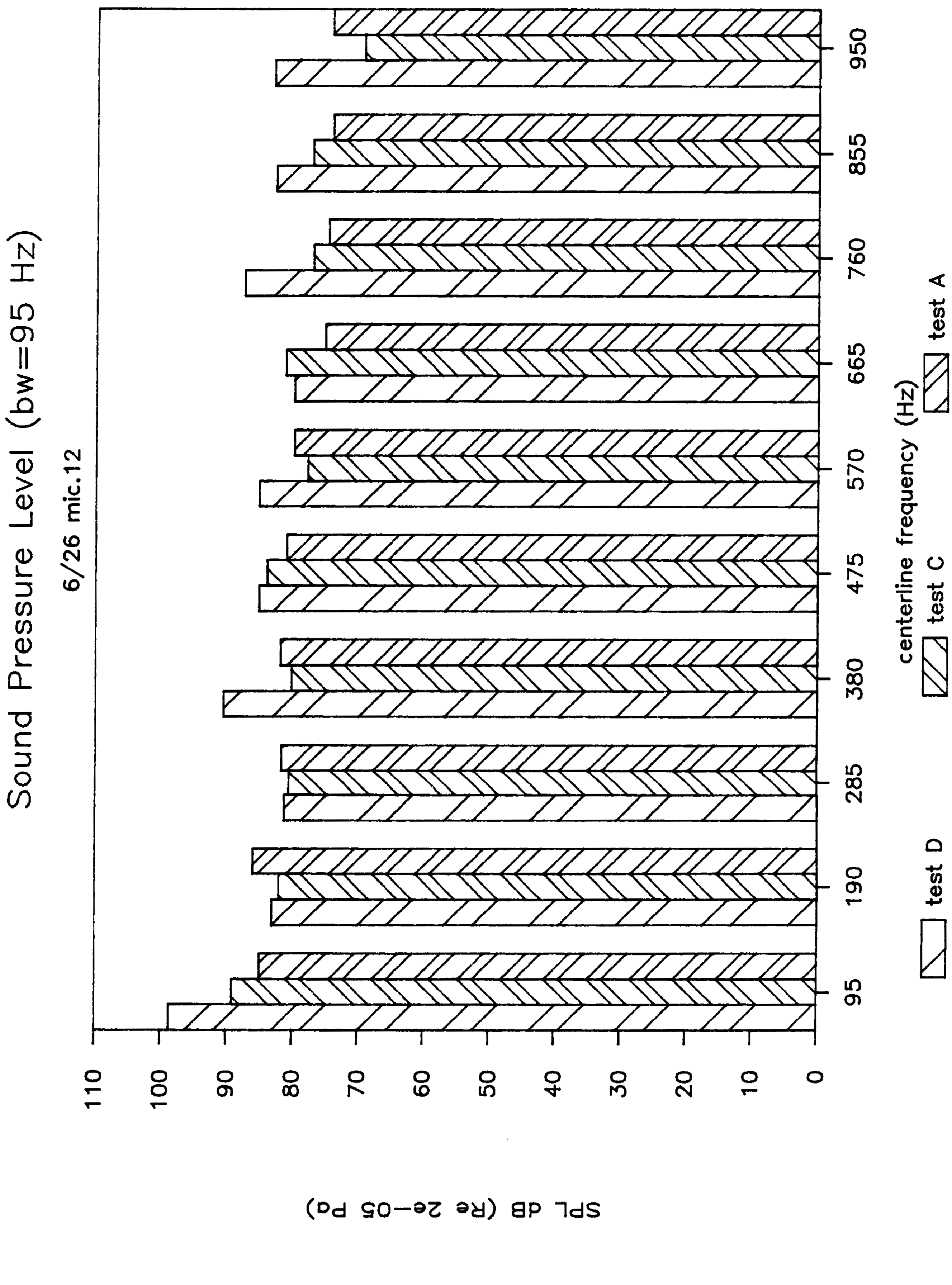

Sound Pressure Level (bw=95 Hz)
6/26 mic.8
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

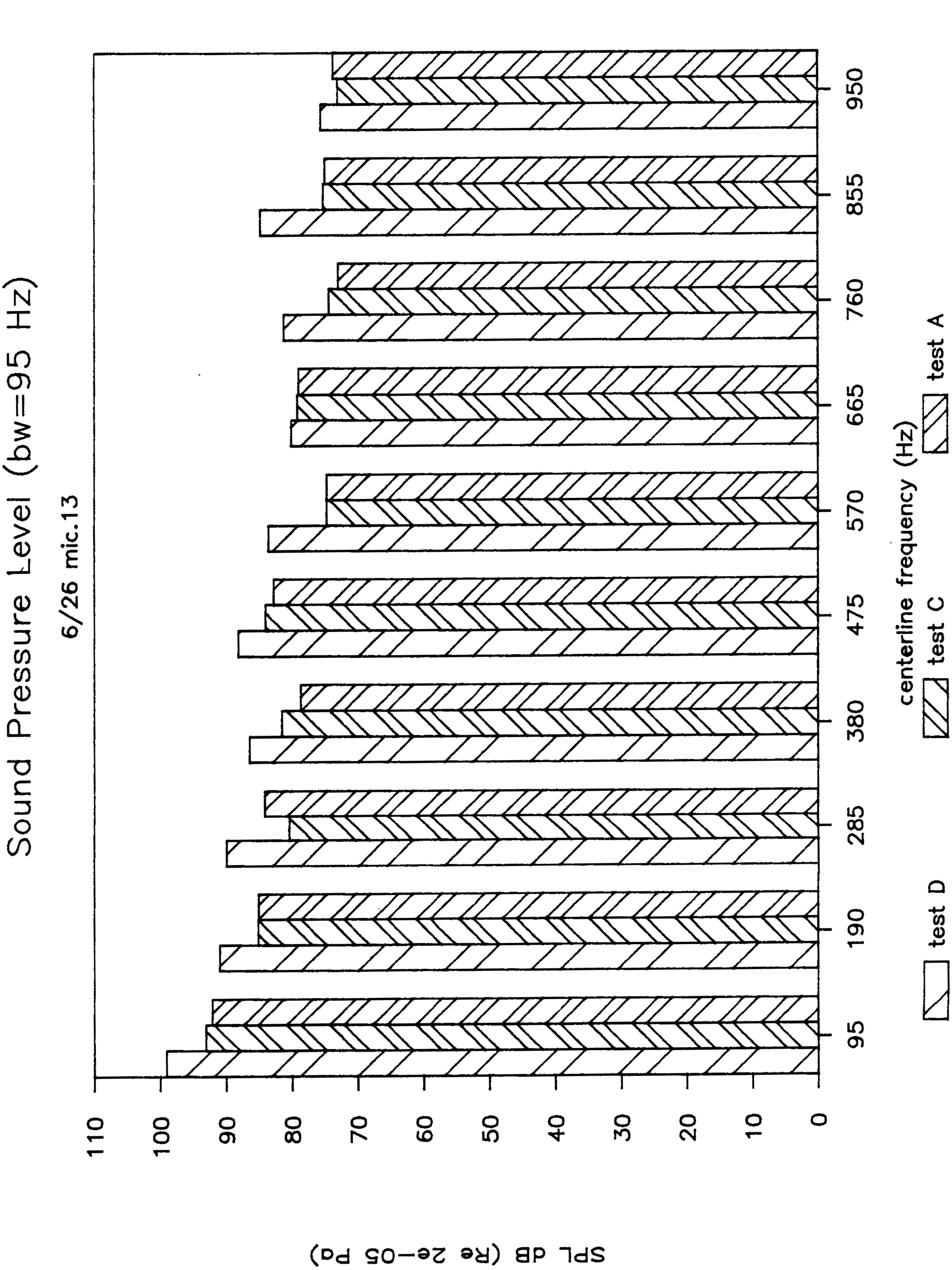

Sound Pressure Level (bw=95 Hz)
6/26 mic.9
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

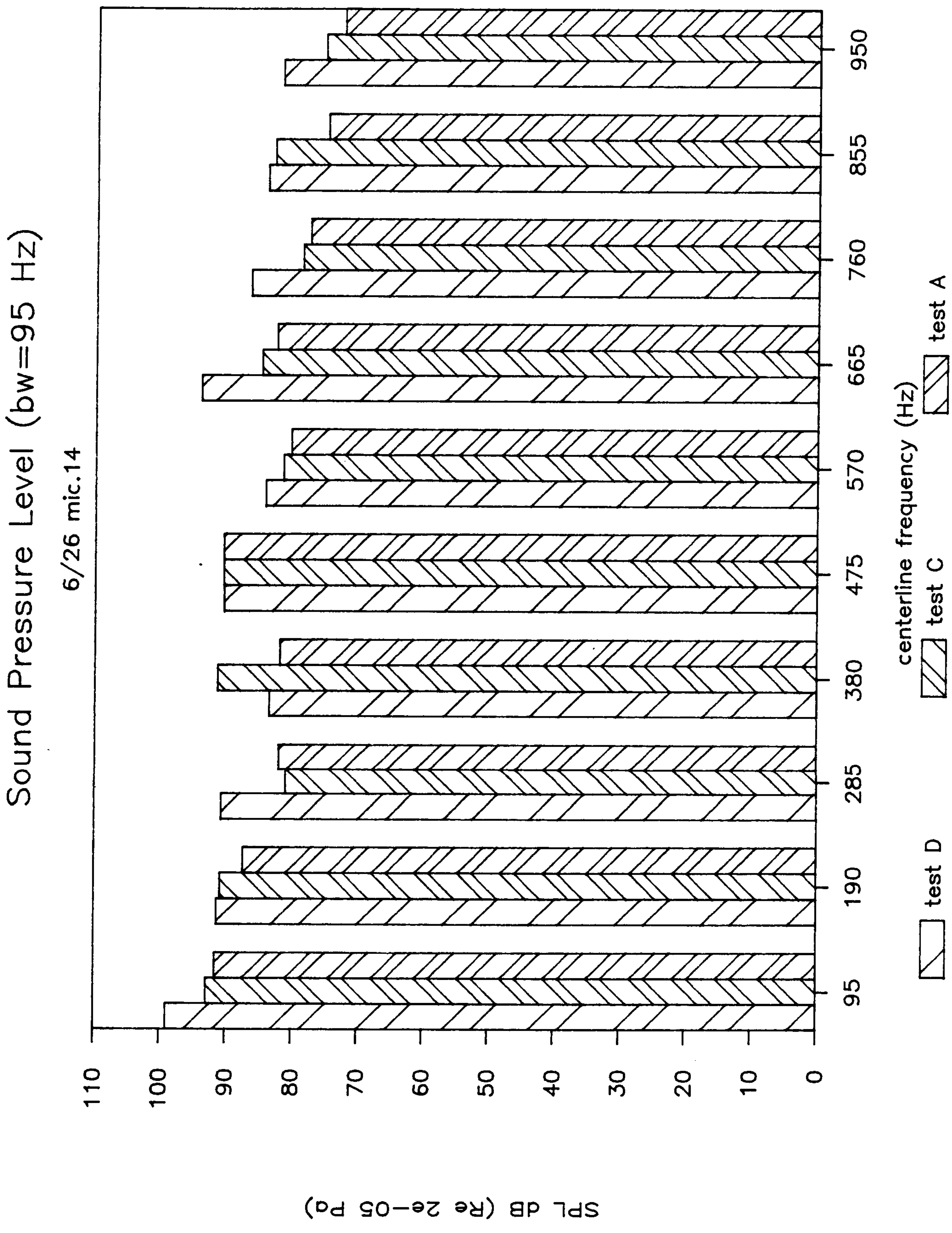


Sound Pressure Level (bw=95 Hz)
6/26 mic.10
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

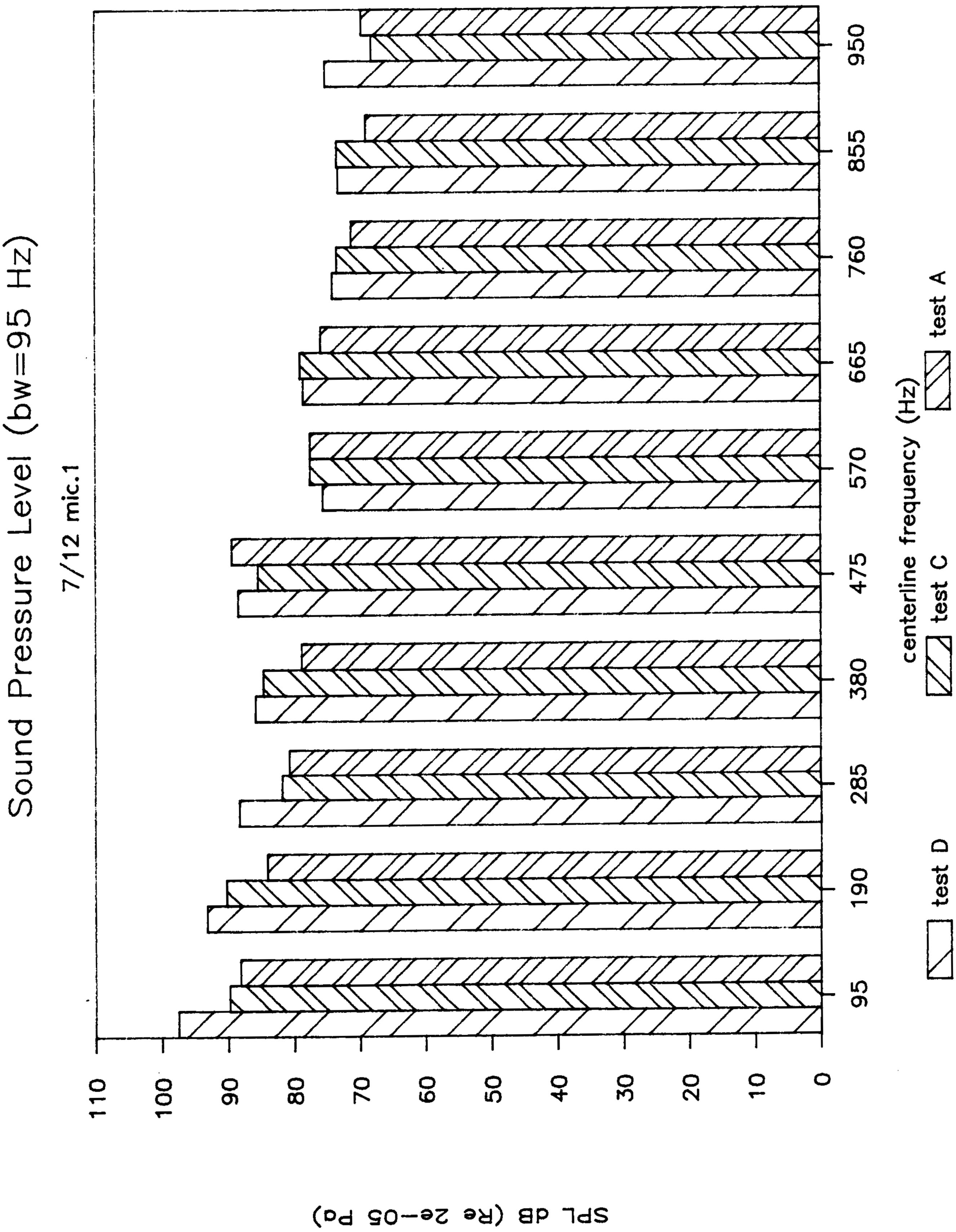

Sound Pressure Level (bw=95 Hz)
6/26 mic.11
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

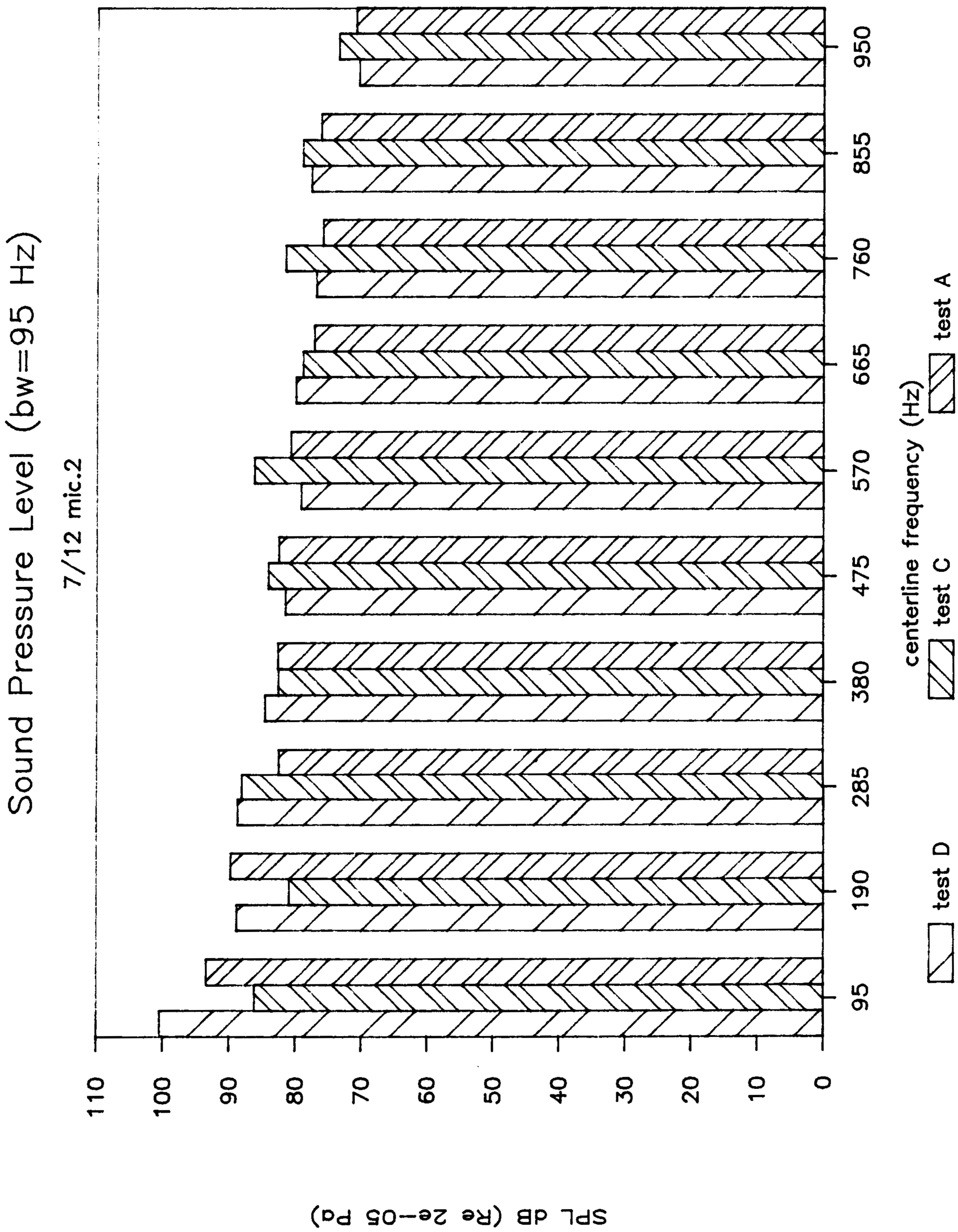

Sound Pressure Level (bw=95 Hz)
6/26 mic.12
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

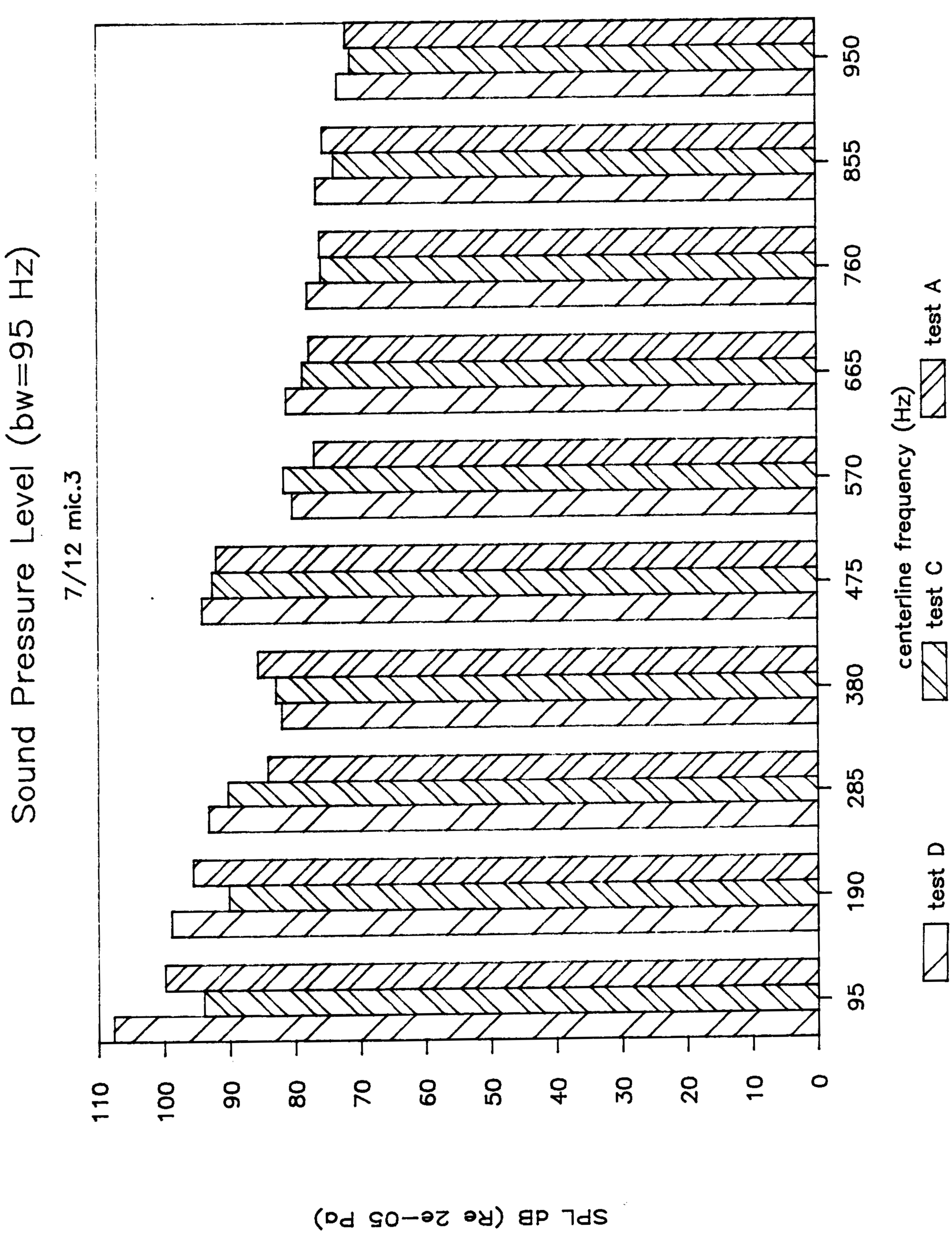

Sound Pressure Level (bw=95 Hz)
6/26 mic.13
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A



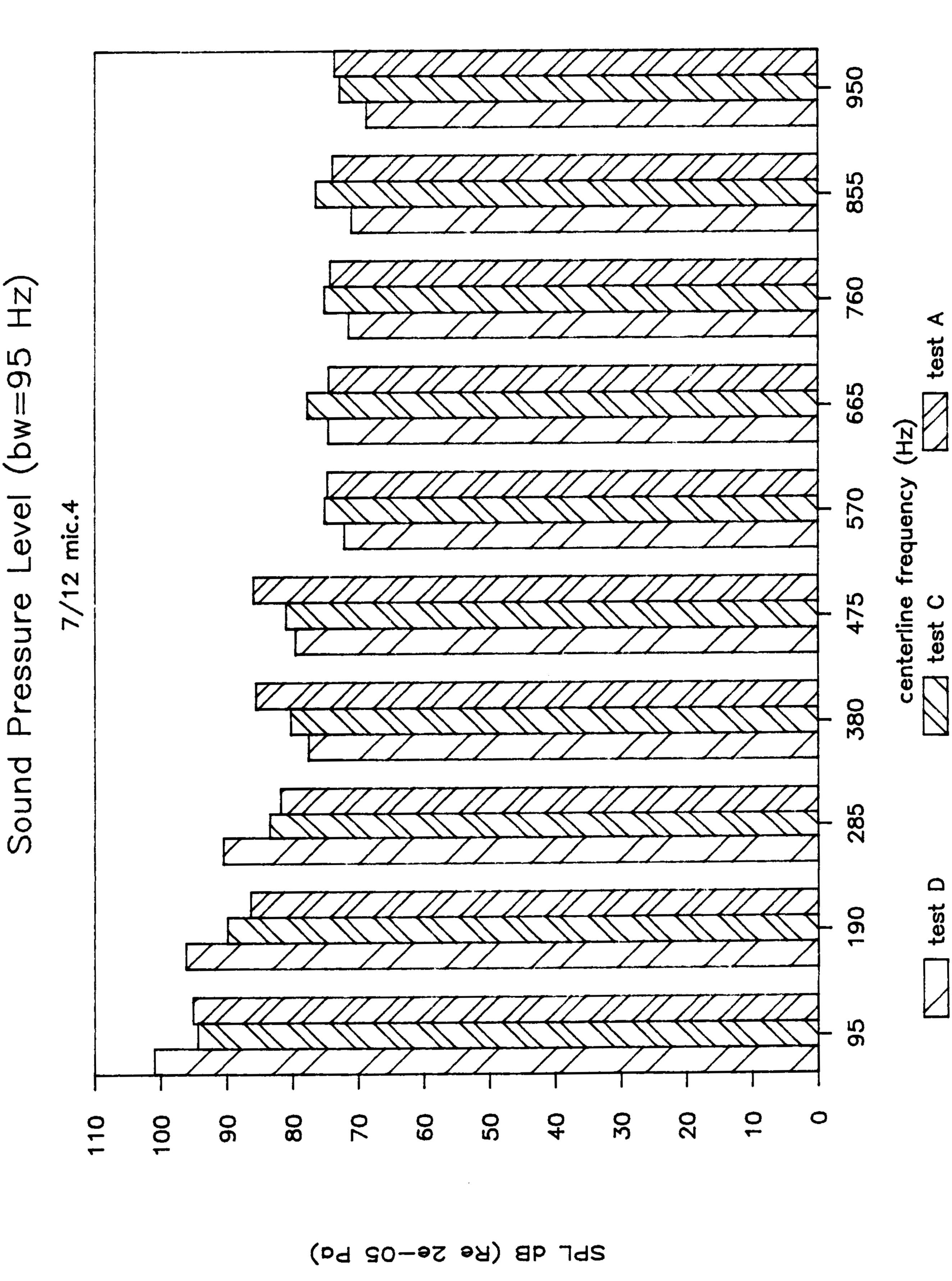
Sound Pressure Level (bw=95 Hz)
6/26 mic.14
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

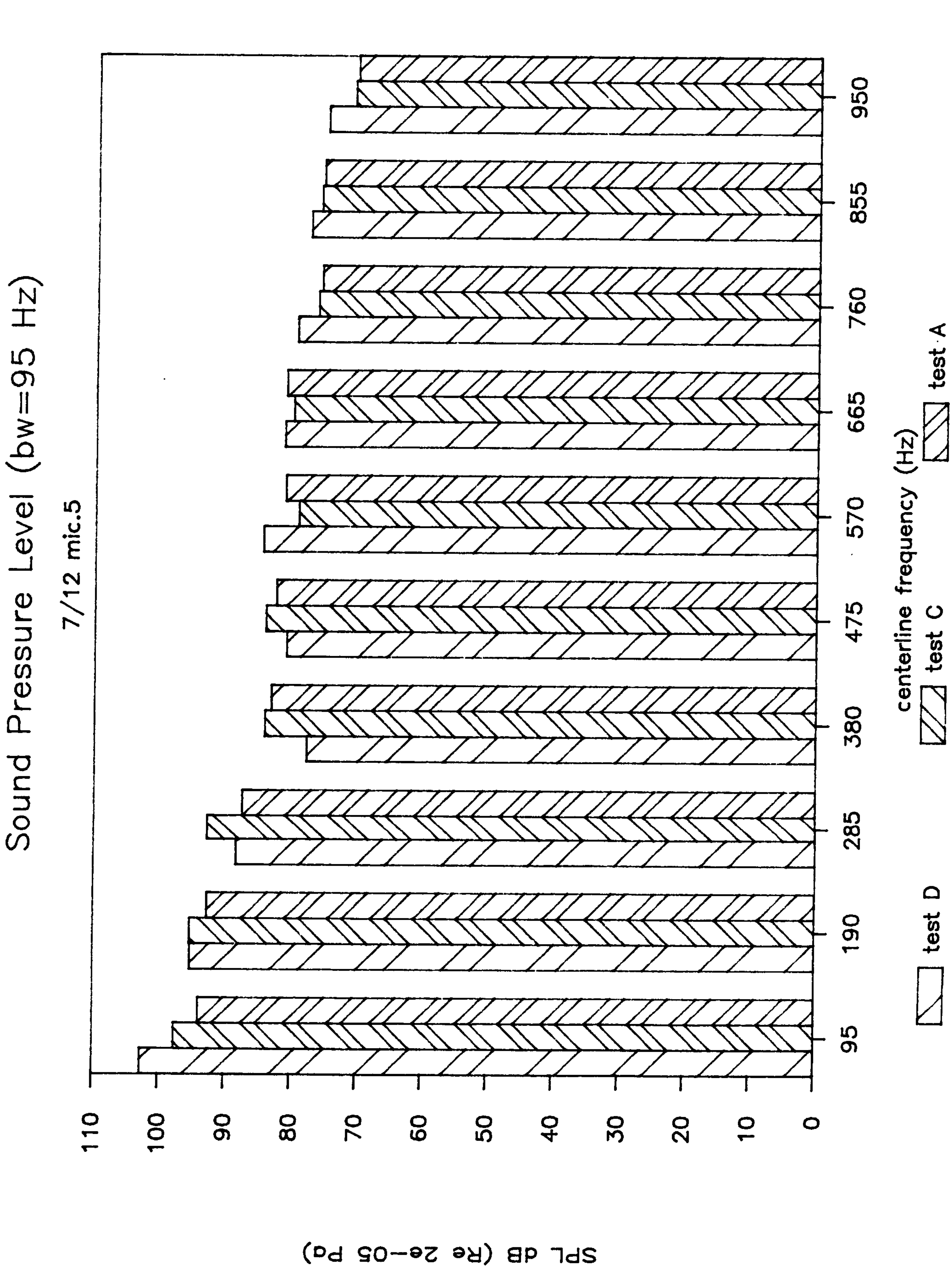

Sound Pressure Level (bw=95 Hz)
7/12 mic.1
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

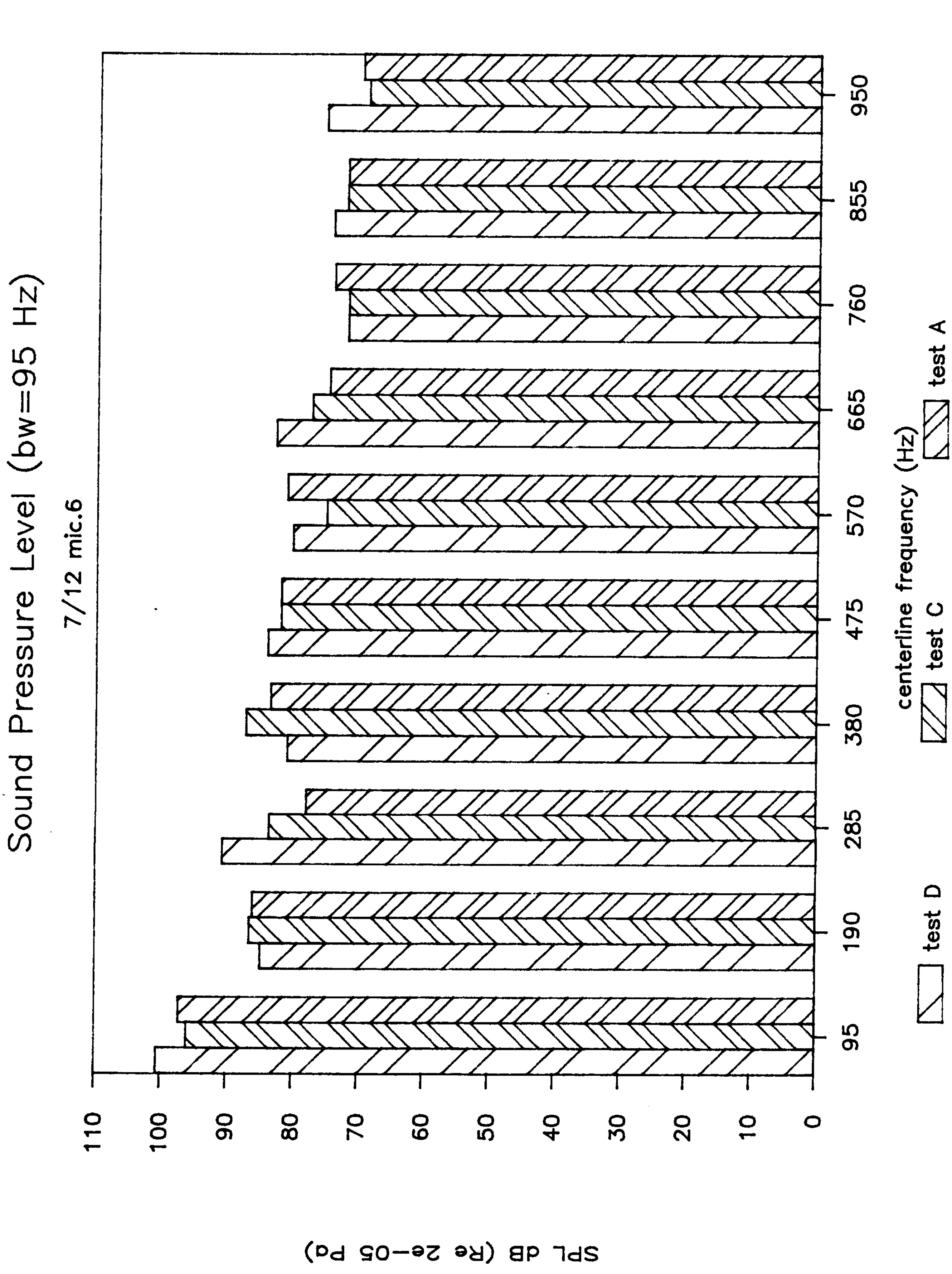

Sound Pressure Level (bw=95 Hz)
7/12 mic.2
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

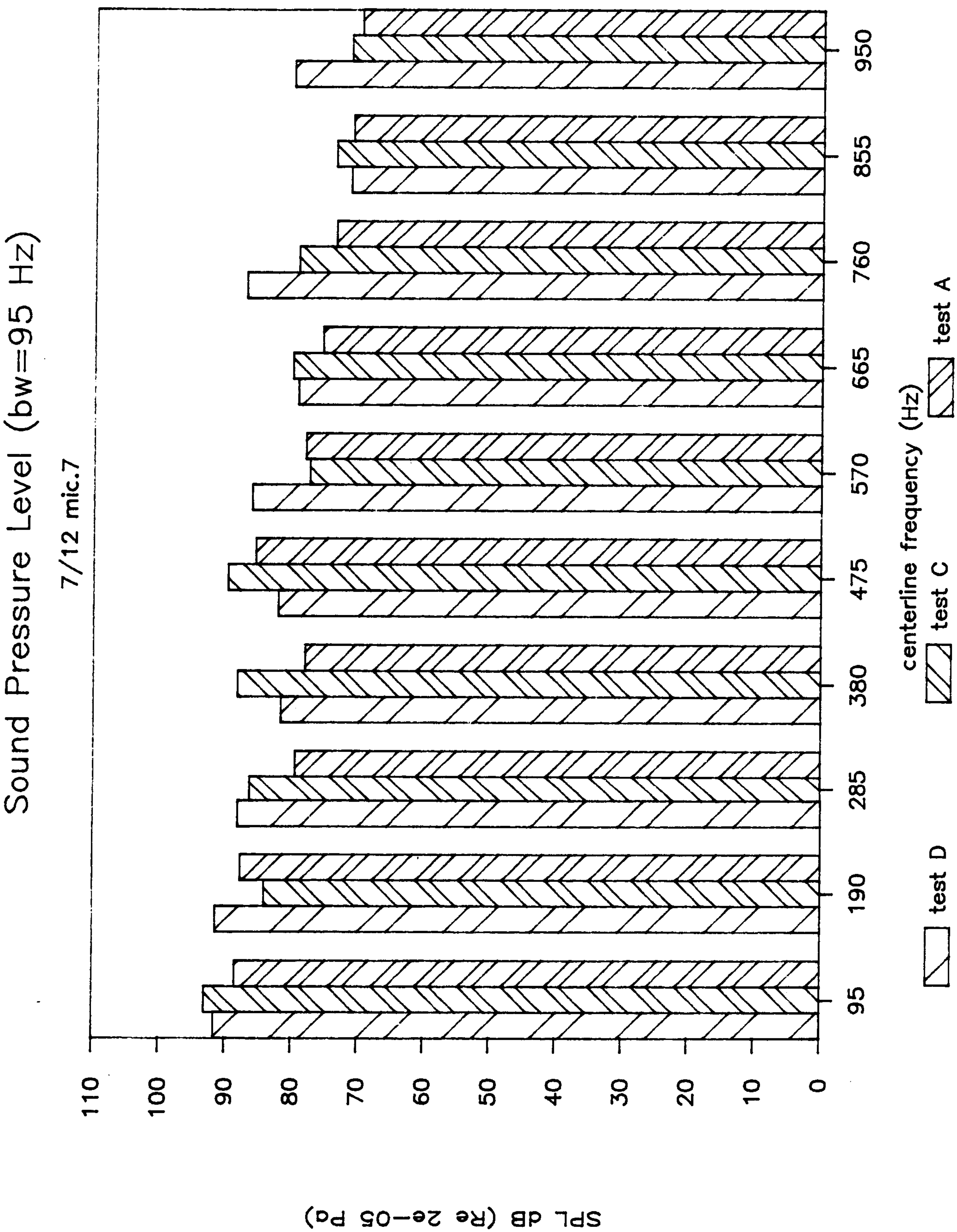


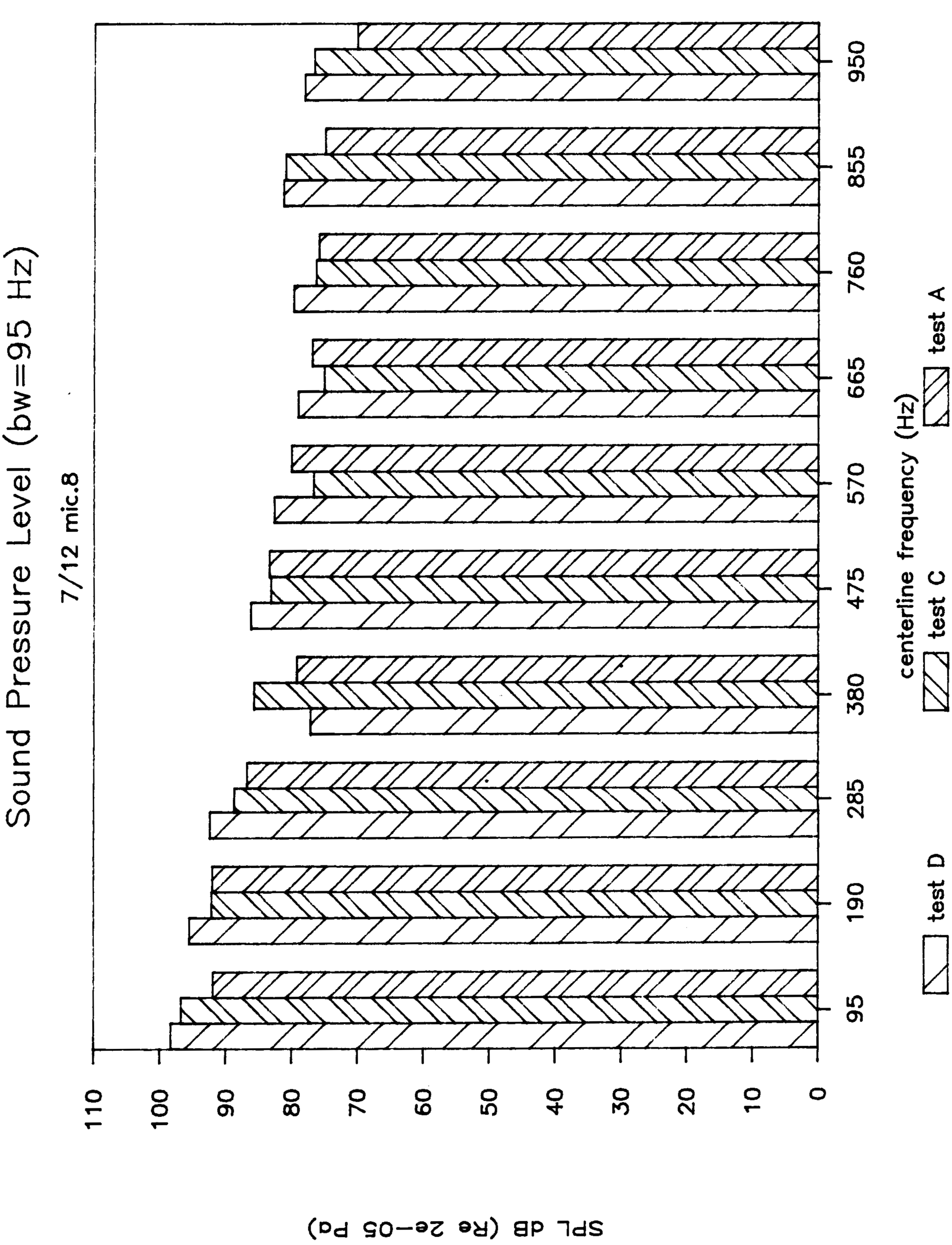
Sound Pressure Level (bw=95 Hz)
7/12 mic.3
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

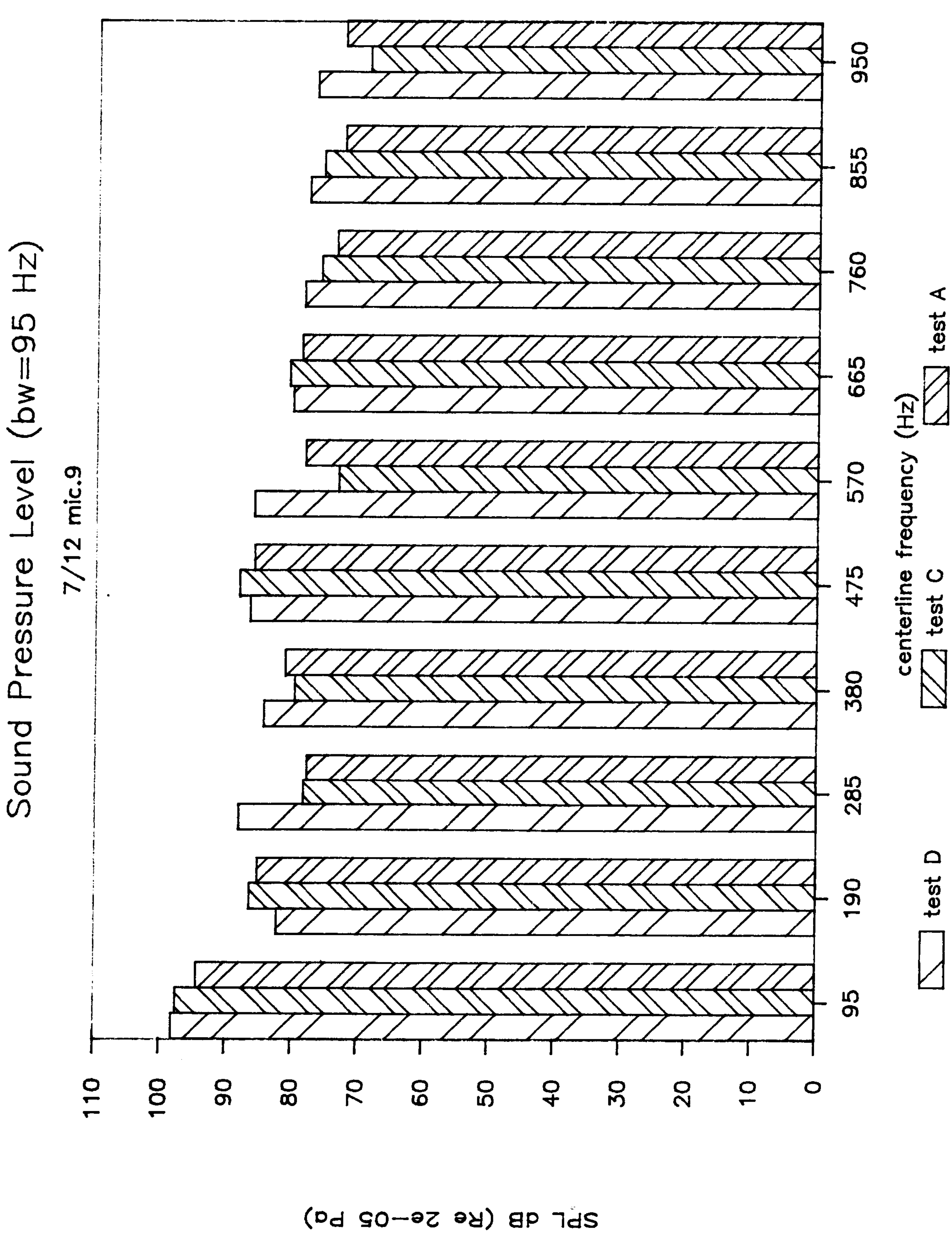

Sound Pressure Level (bw=95 Hz)
7/12 mic.4
SPL dB (Re 2e−05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

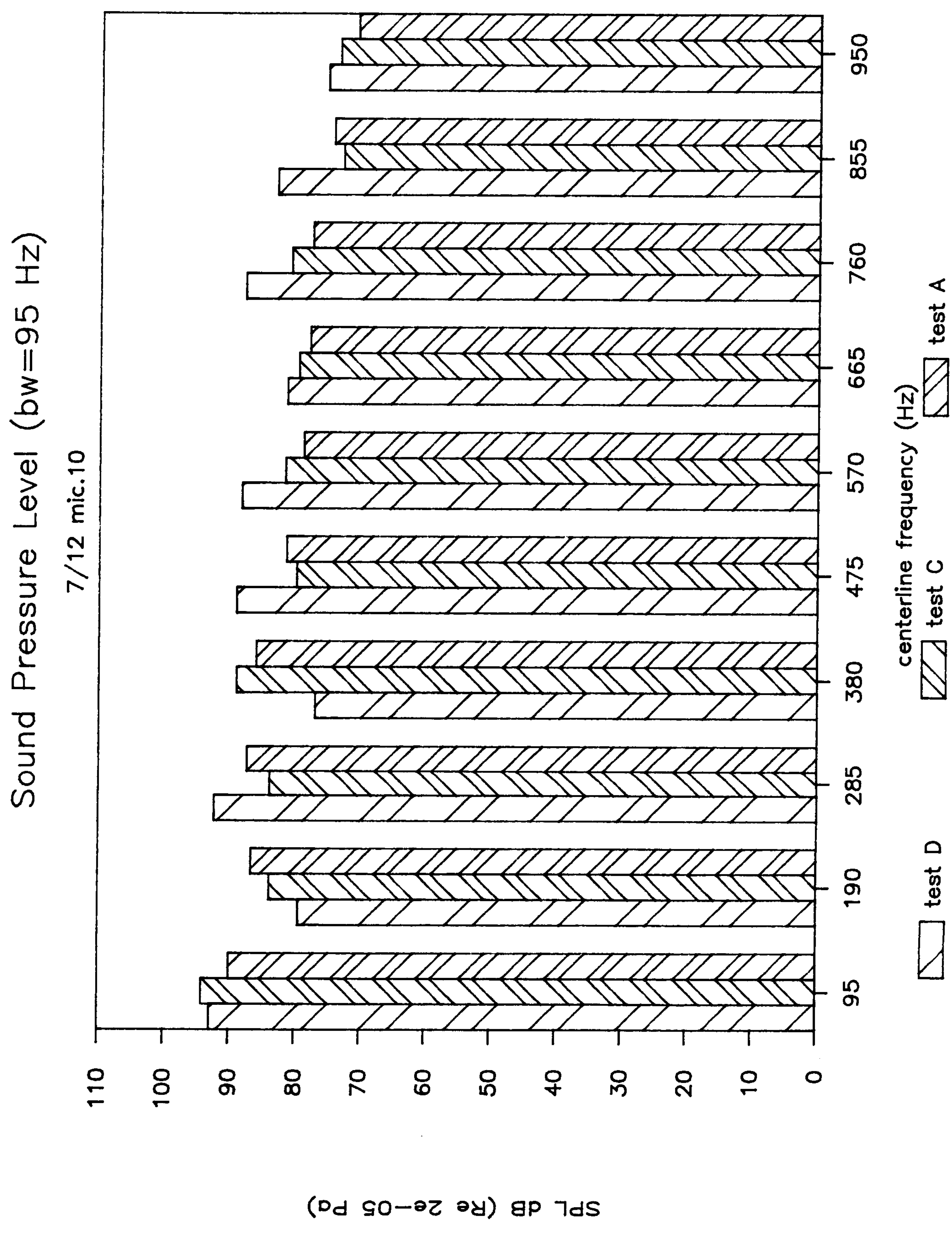

Sound Pressure Level (bw=95 Hz)
7/12 mic.5
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

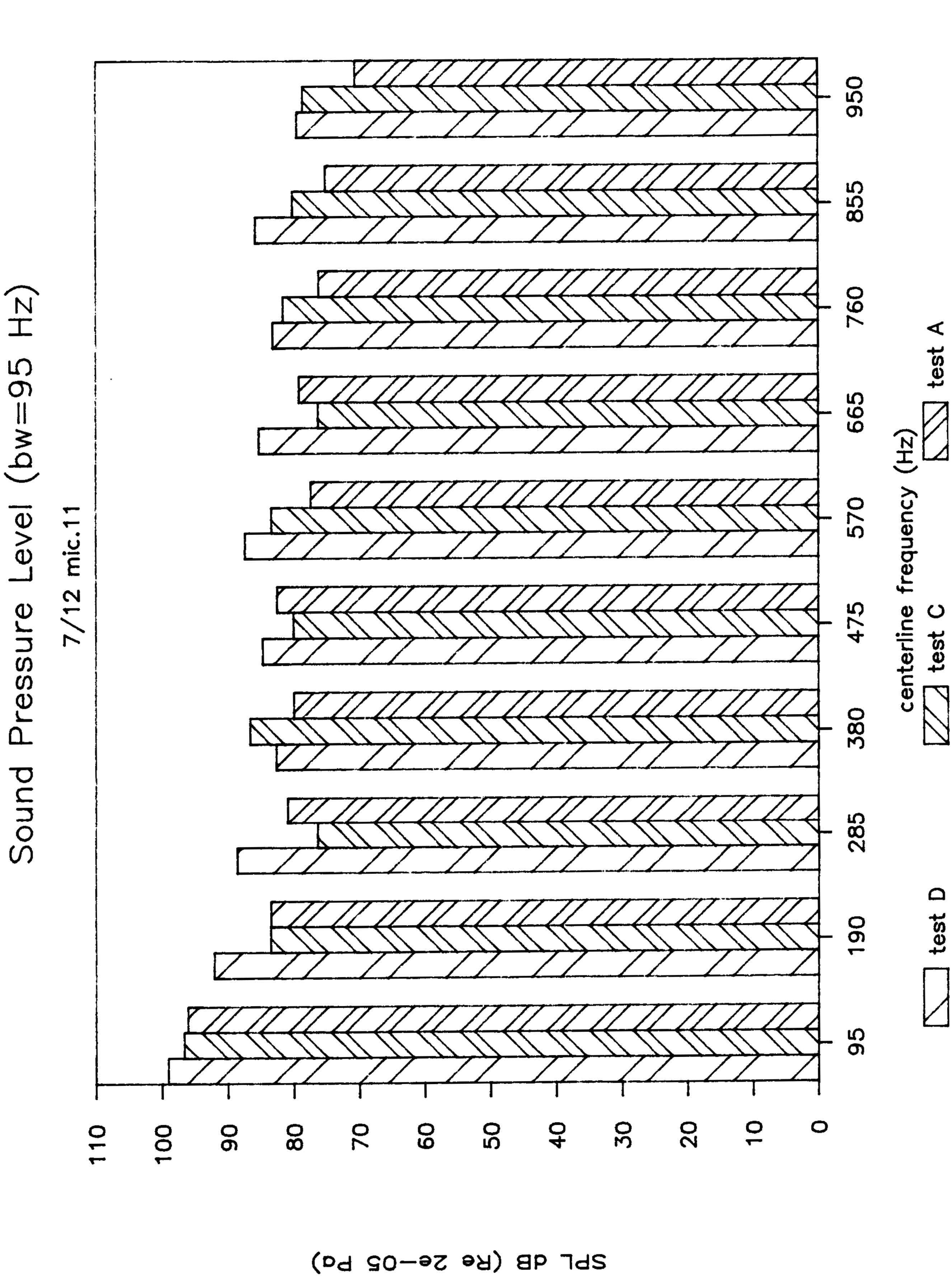

Sound Pressure Level (bw=95 Hz)
7/12 mic.6
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

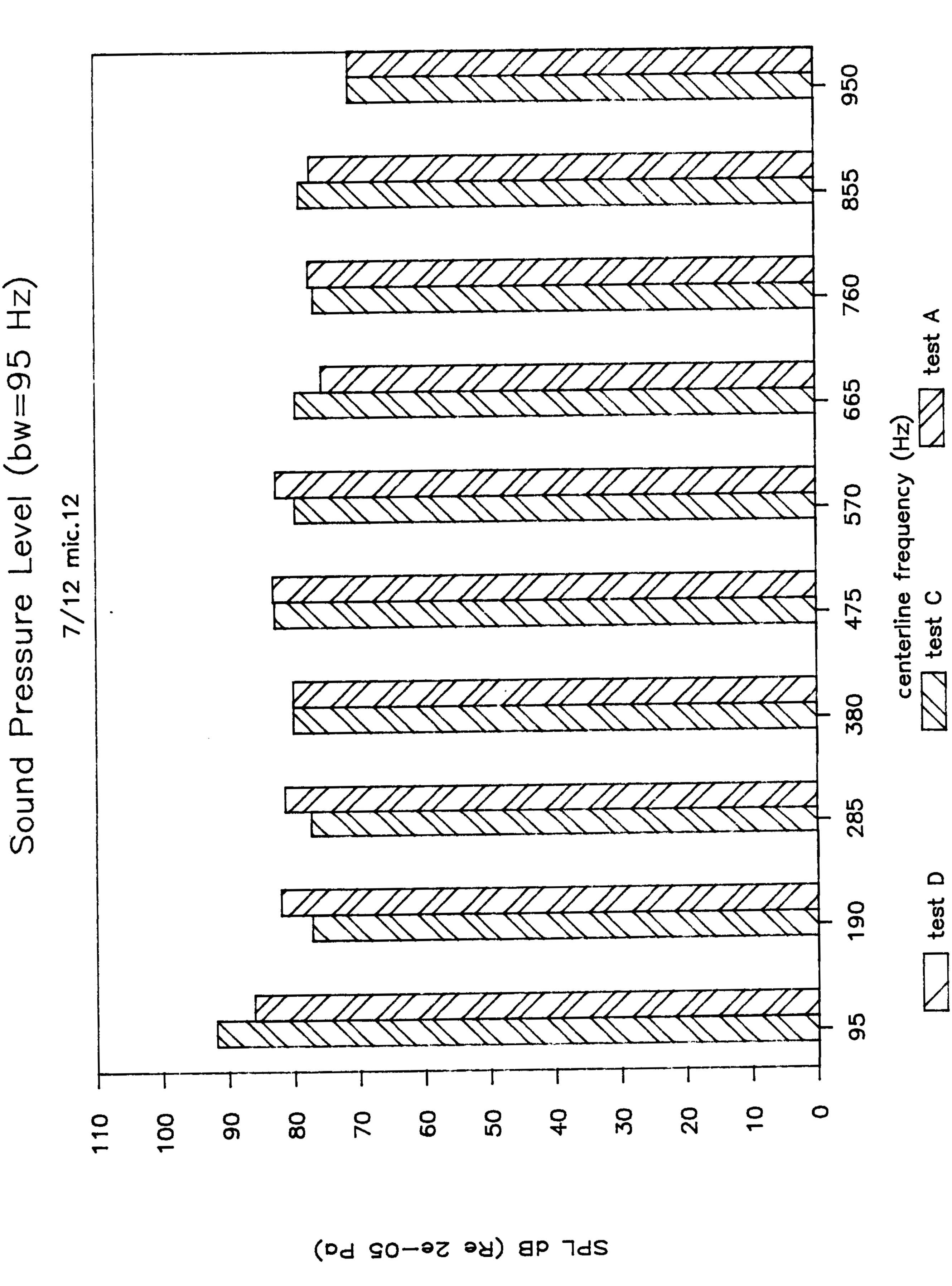

Sound Pressure Level (bw=95 Hz)
7/12 mic.7
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A


Sound Pressure Level (bw=95 Hz)
7/12 mic.8
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

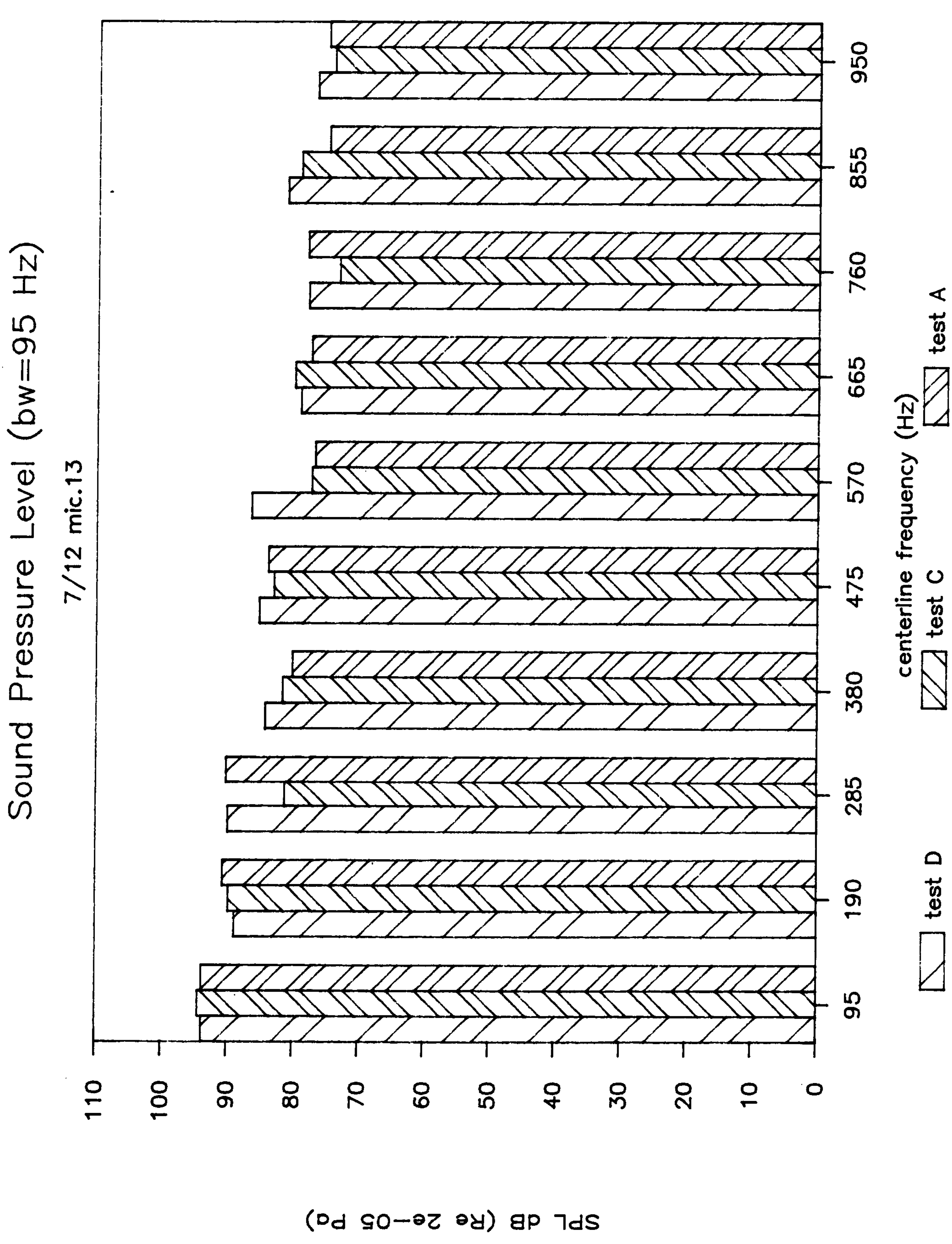

Sound Pressure Level (bw=95 Hz)
7/12 mic.9
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

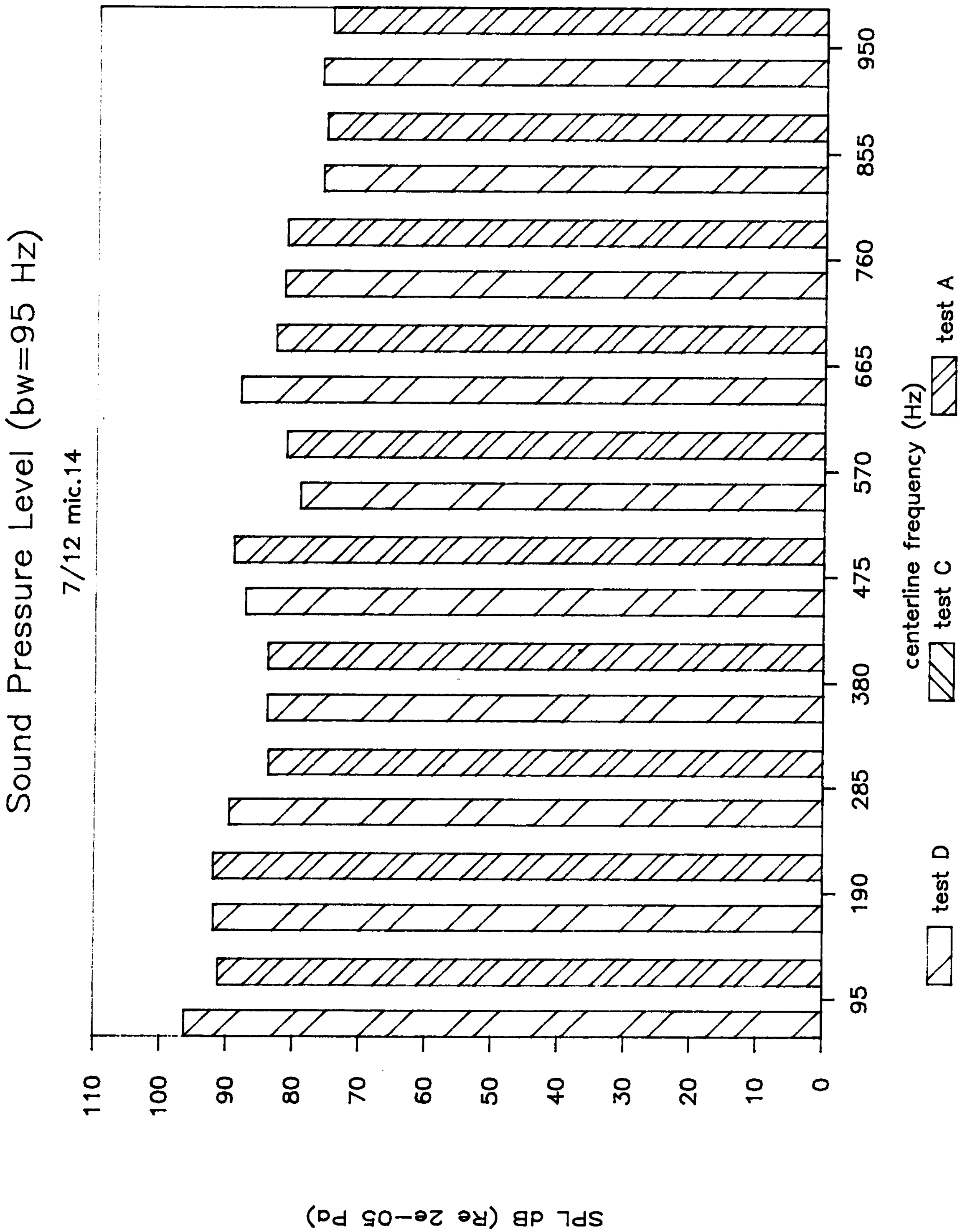

Sound Pressure Level (bw=95 Hz)
7/12 mic.10
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

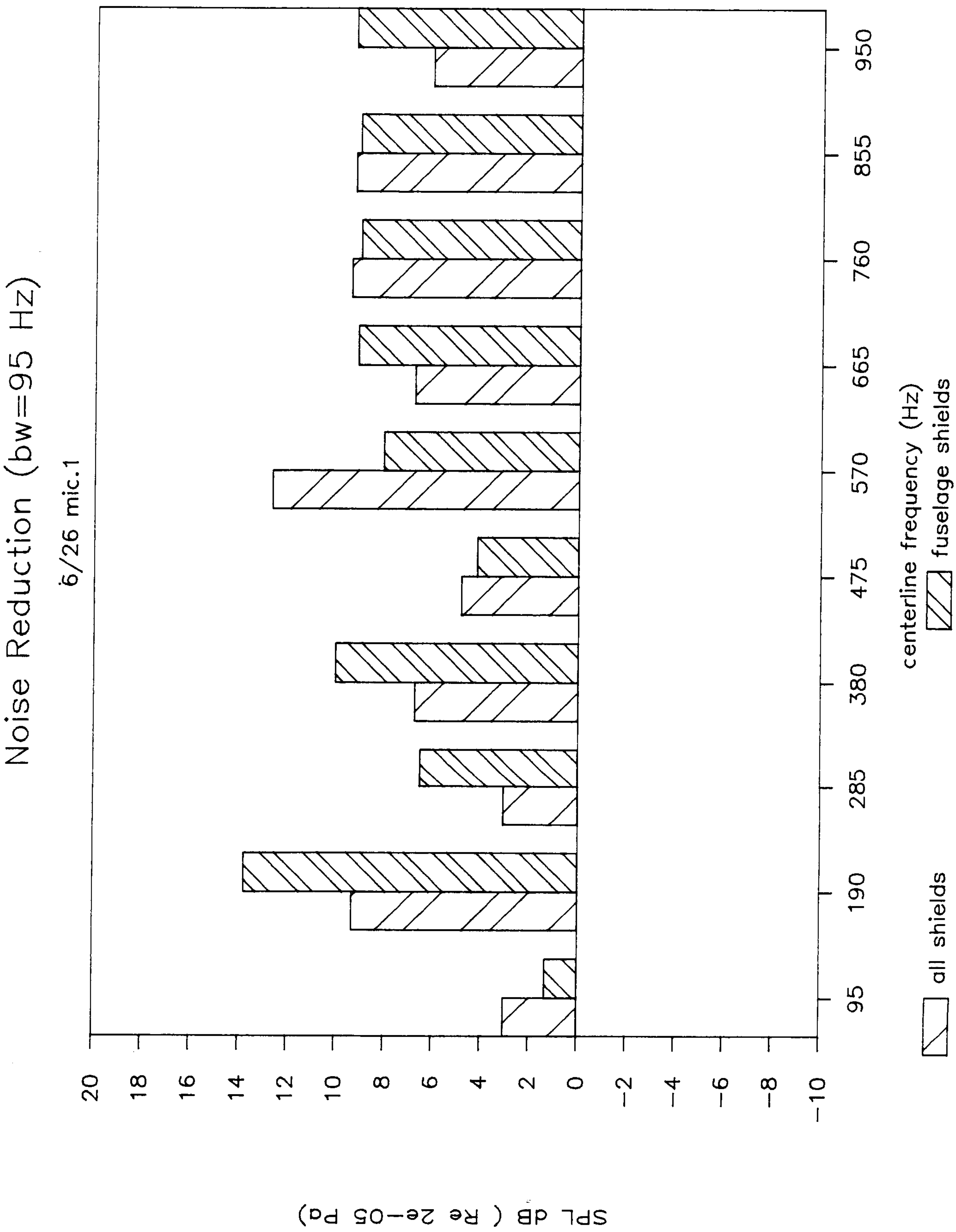

Sound Pressure Level (bw=95 Hz)
7/12 mic.11
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A



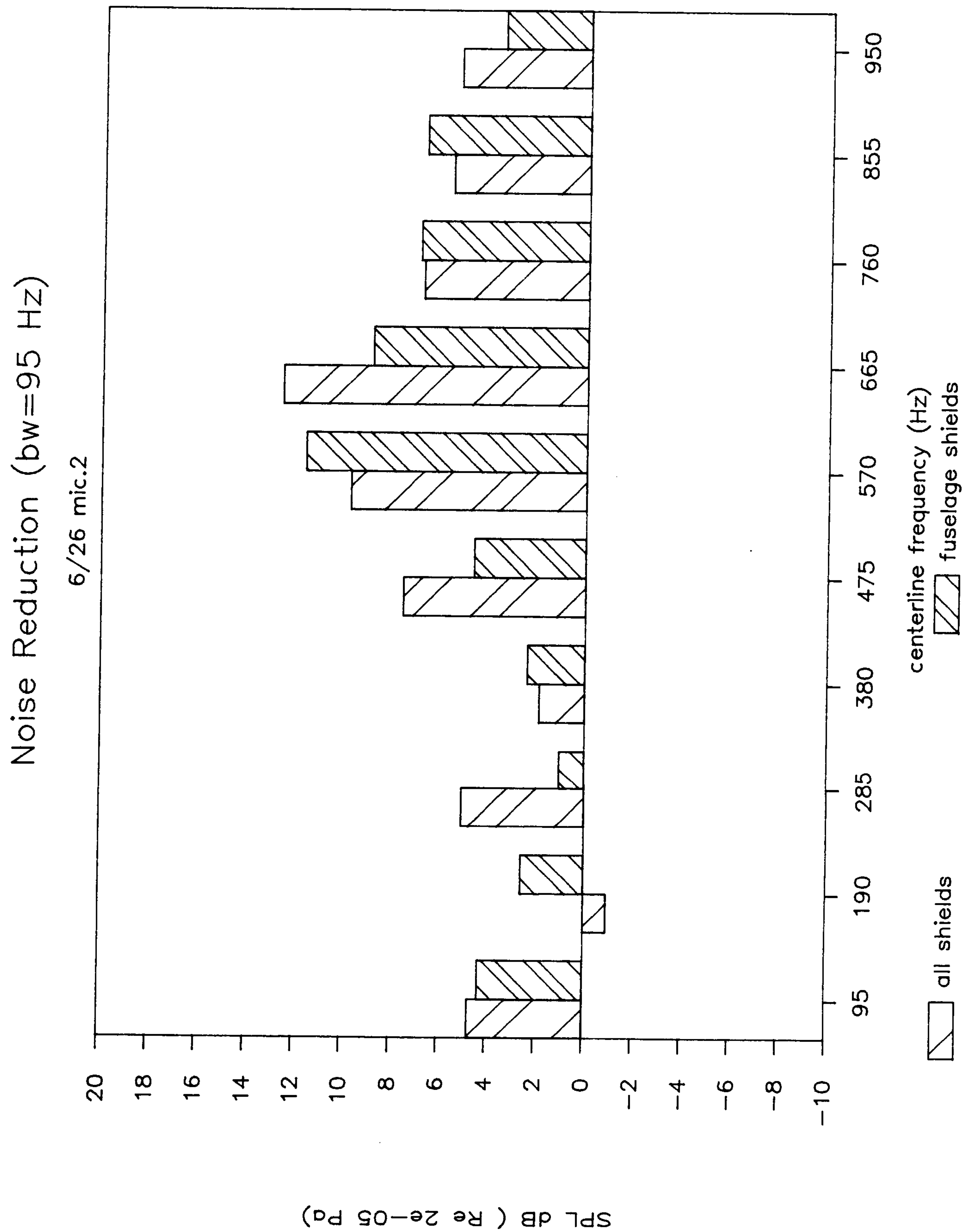
Sound Pressure Level (bw=95 Hz)
7/12 mic.12
SPL dB (Re 2e-05 Pa)
0
10
20
30
40
50
60
70
80
90
100
110
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A


Sound Pressure Level (bw=95 Hz)
7/12 mic.13
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

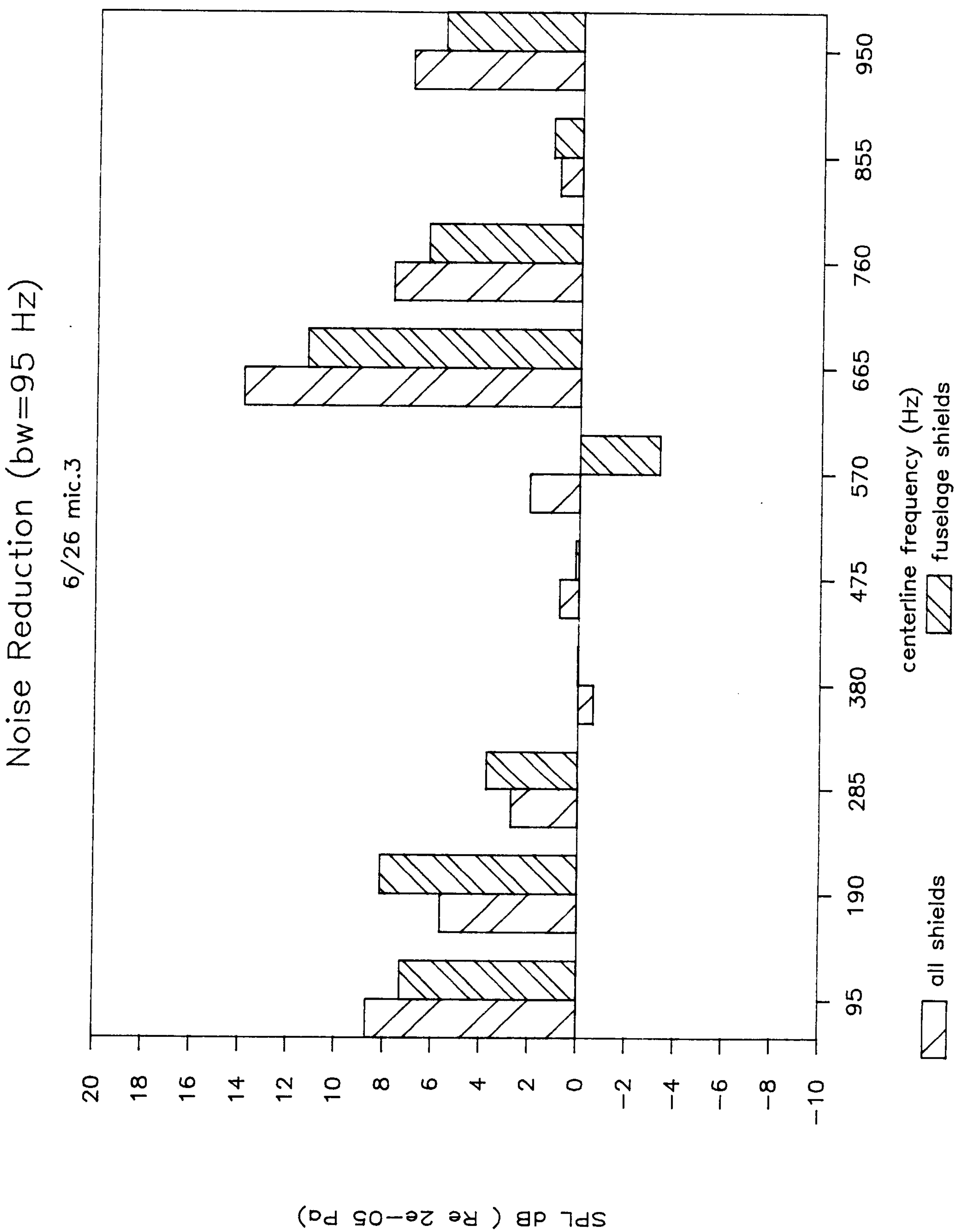

Sound Pressure Level (bw=95 Hz)
7/12 mic.14
SPL dB (Re 2e-05 Pa)
110
100
90
80
70
60
50
40
30
20
10
0
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
test D
test C
test A

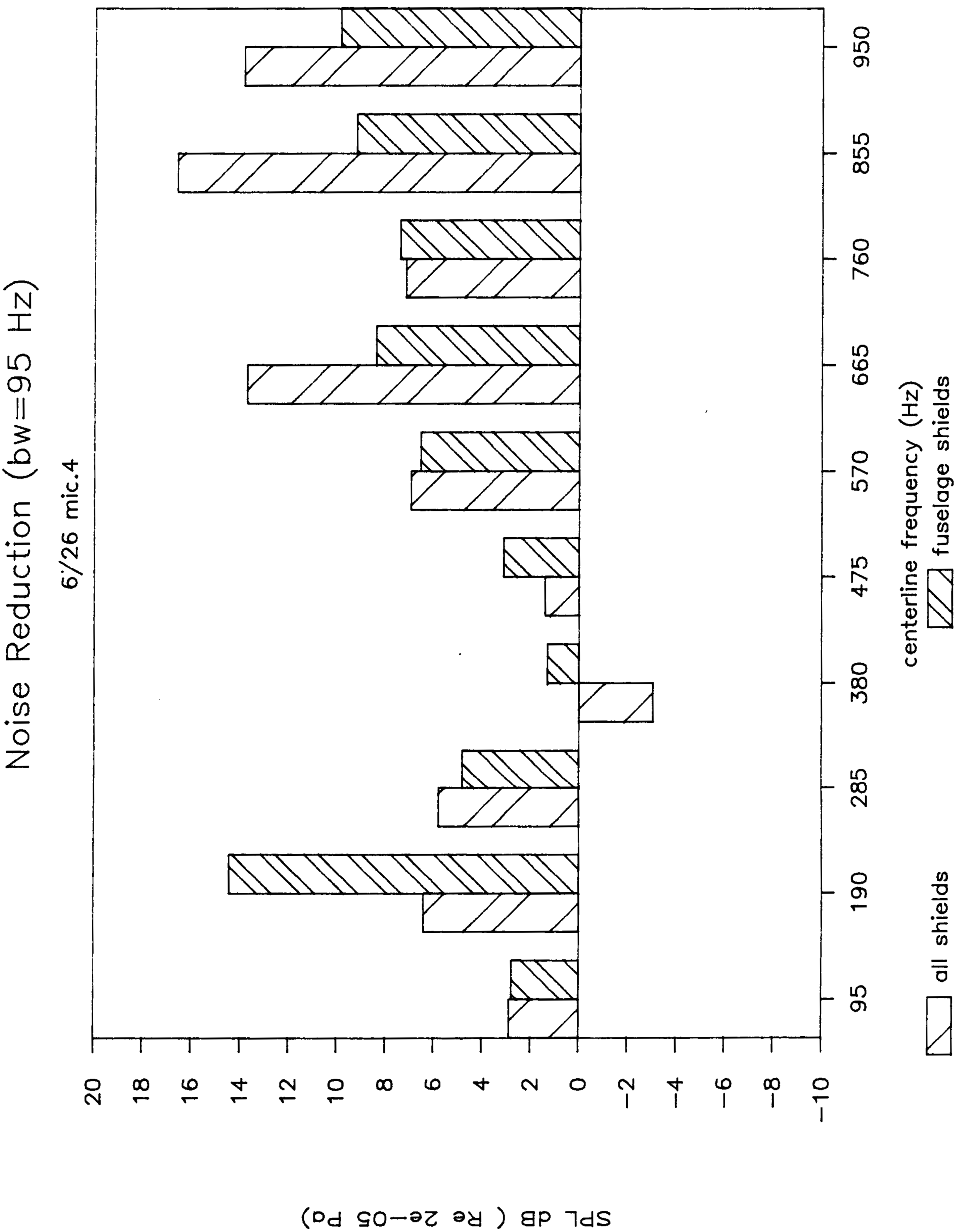


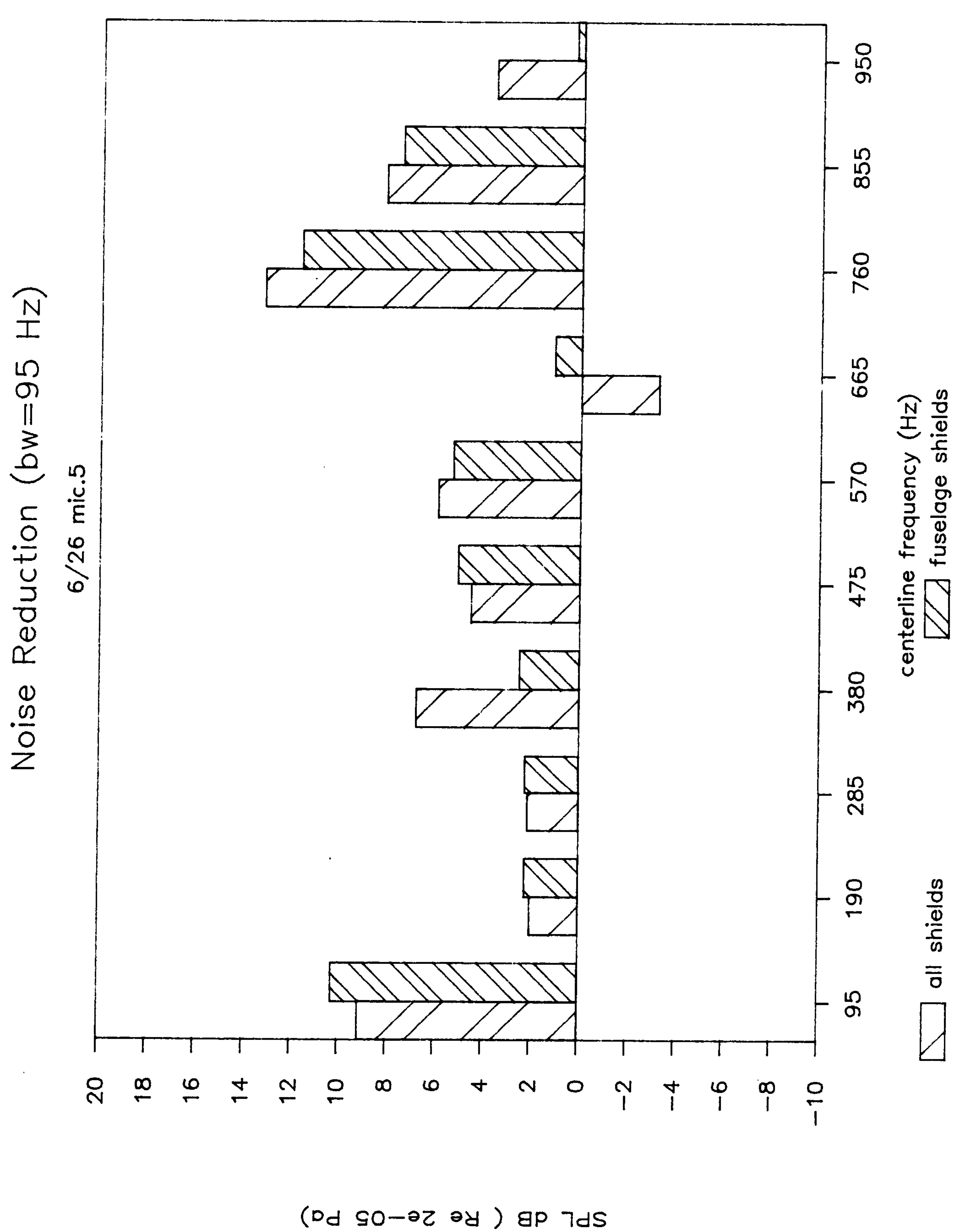
Noise Reduction (bw=95 Hz)
6/26 mic.1
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

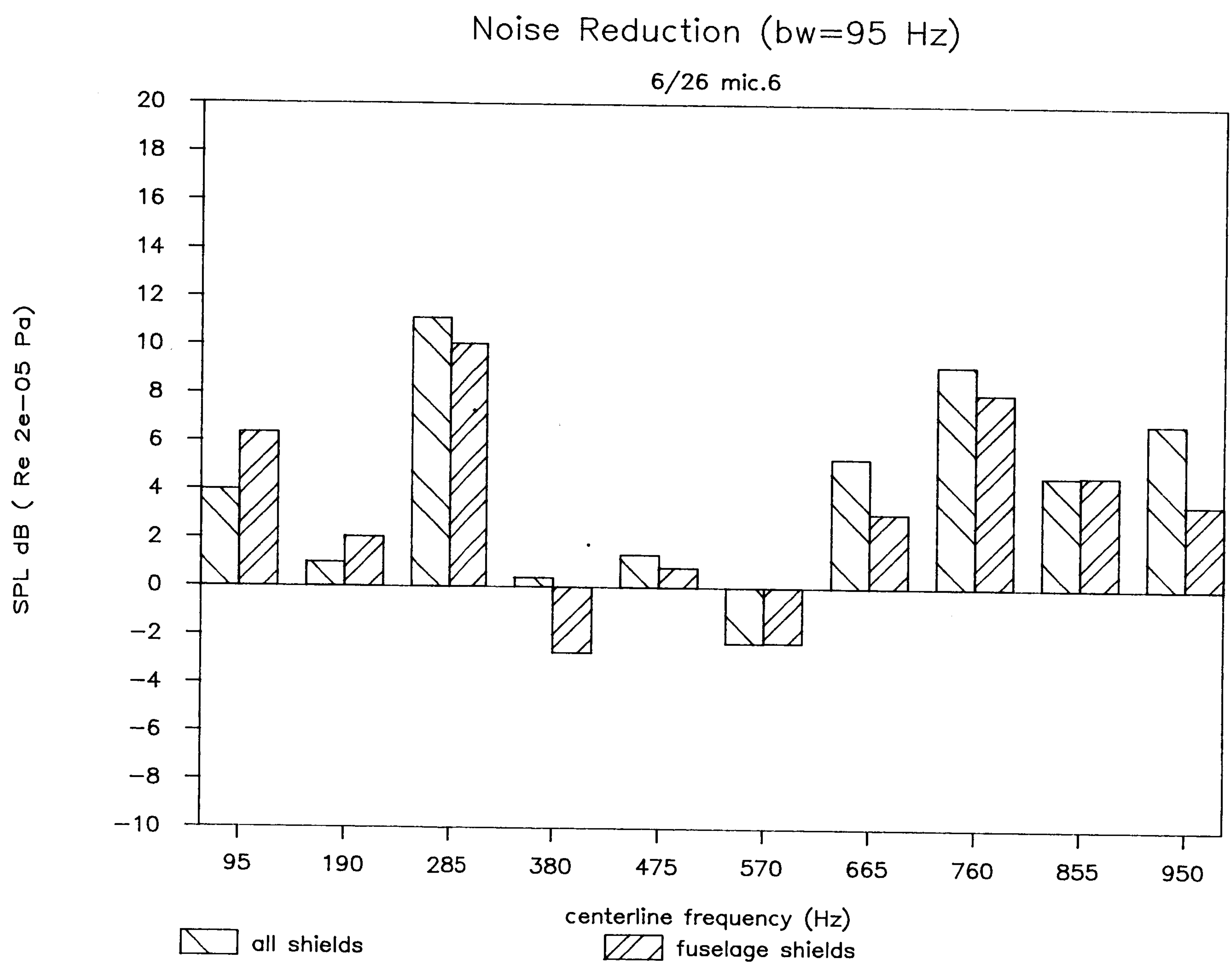


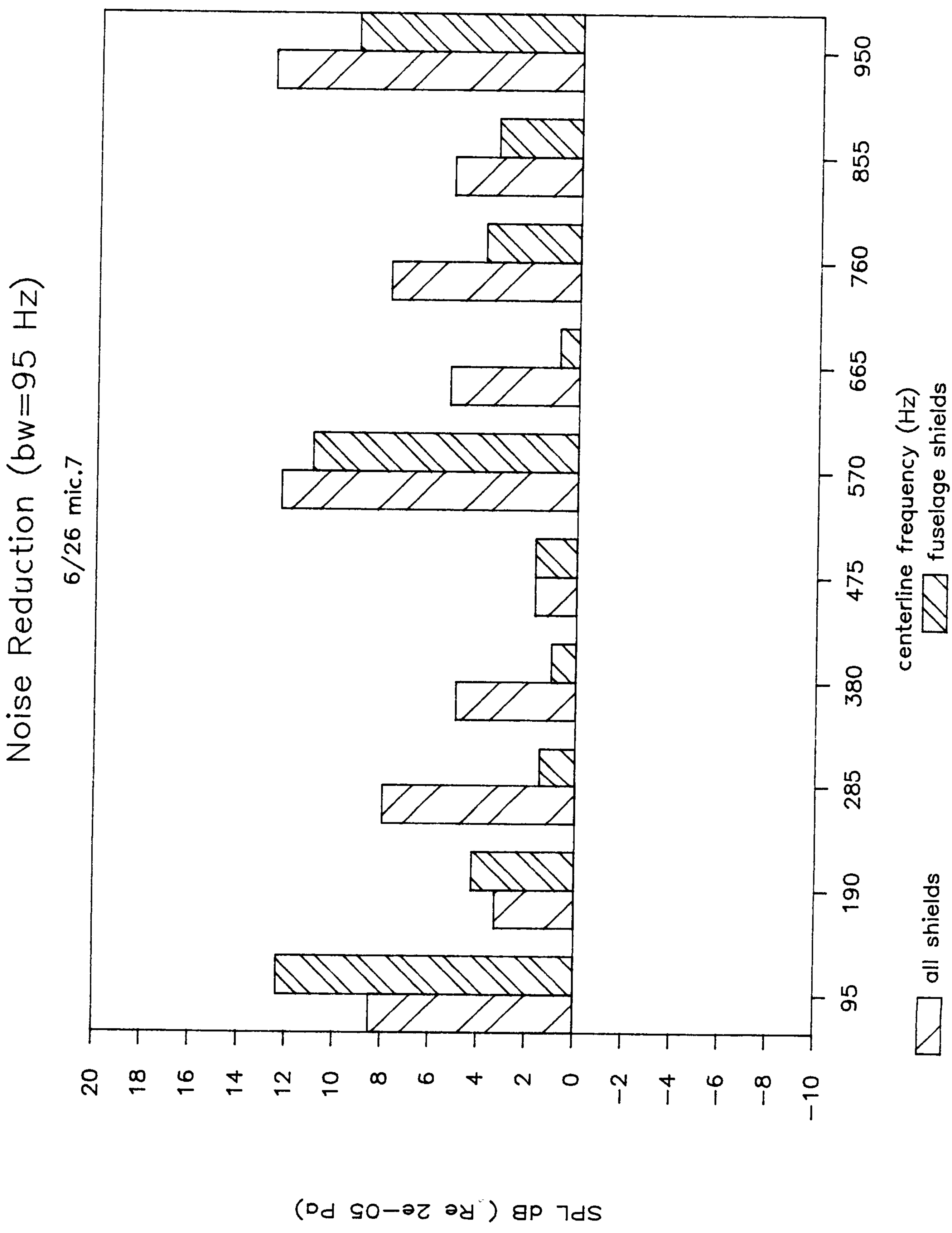
Noise Reduction (bw=95 Hz)
6/26 mic.2
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
6/26 mic.3
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

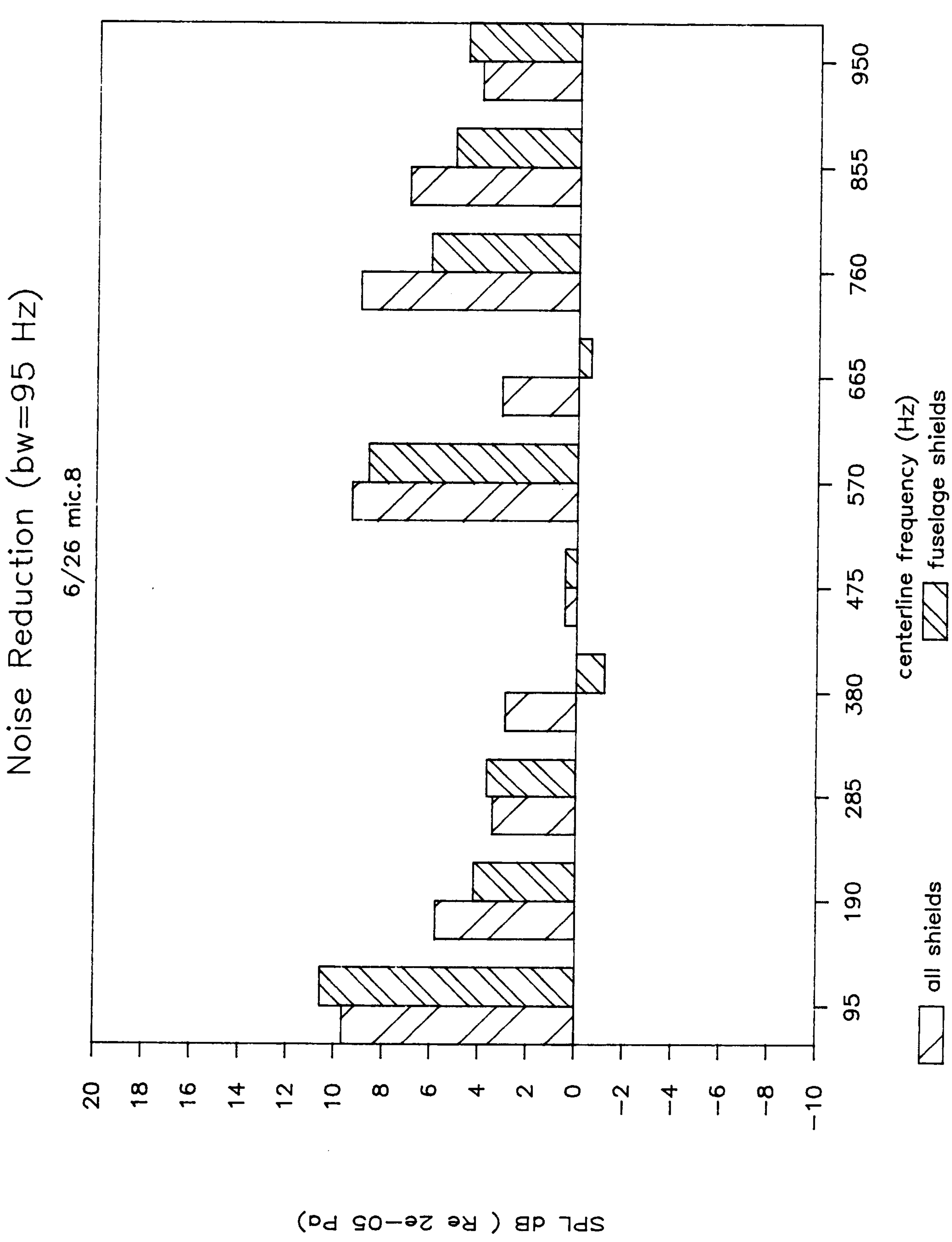

Noise Reduction (bw=95 Hz)
6/26 mic.4
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
6/26 mic.5
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

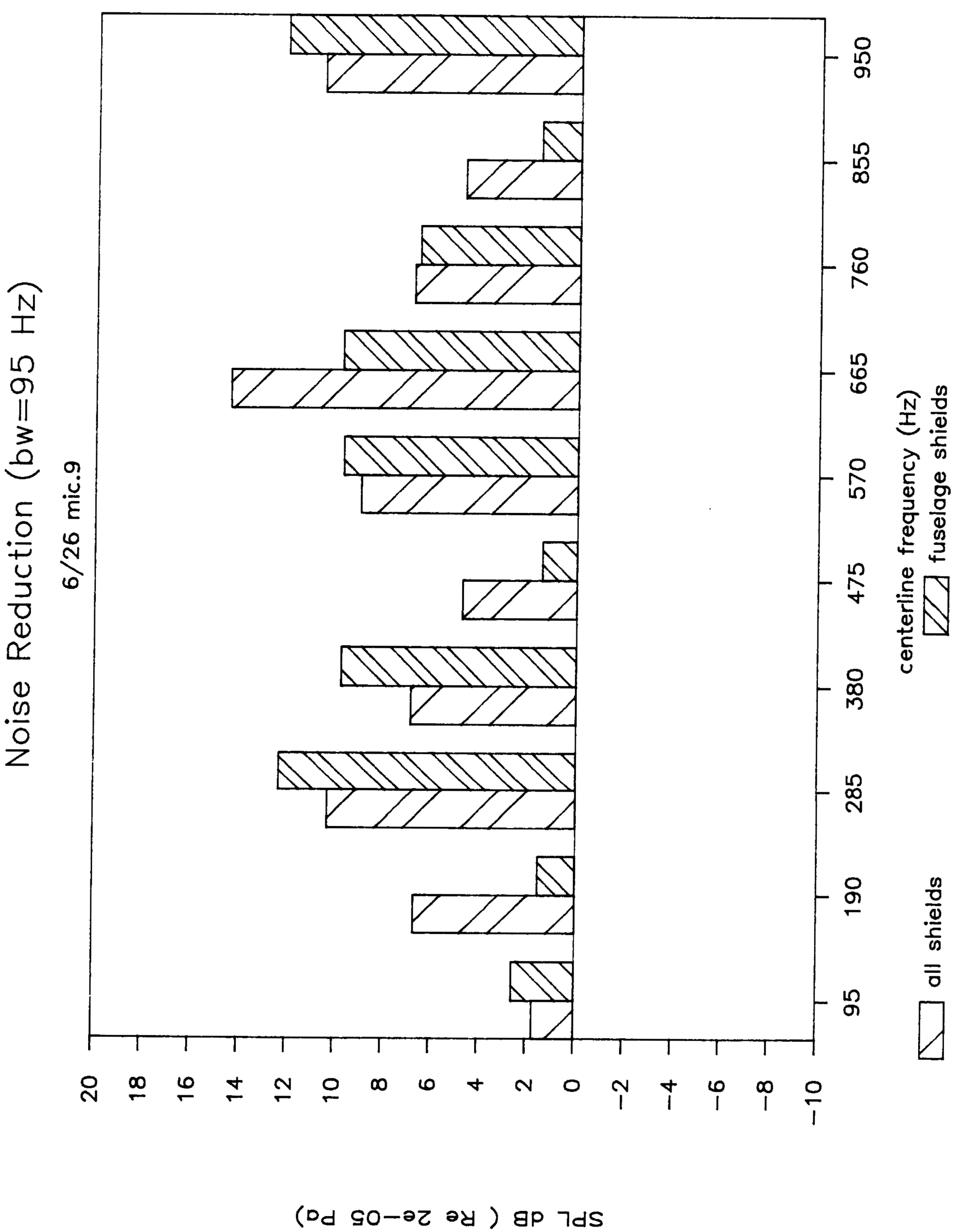

Noise Reduction (bw=95 Hz)
6/26 mic.6
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields



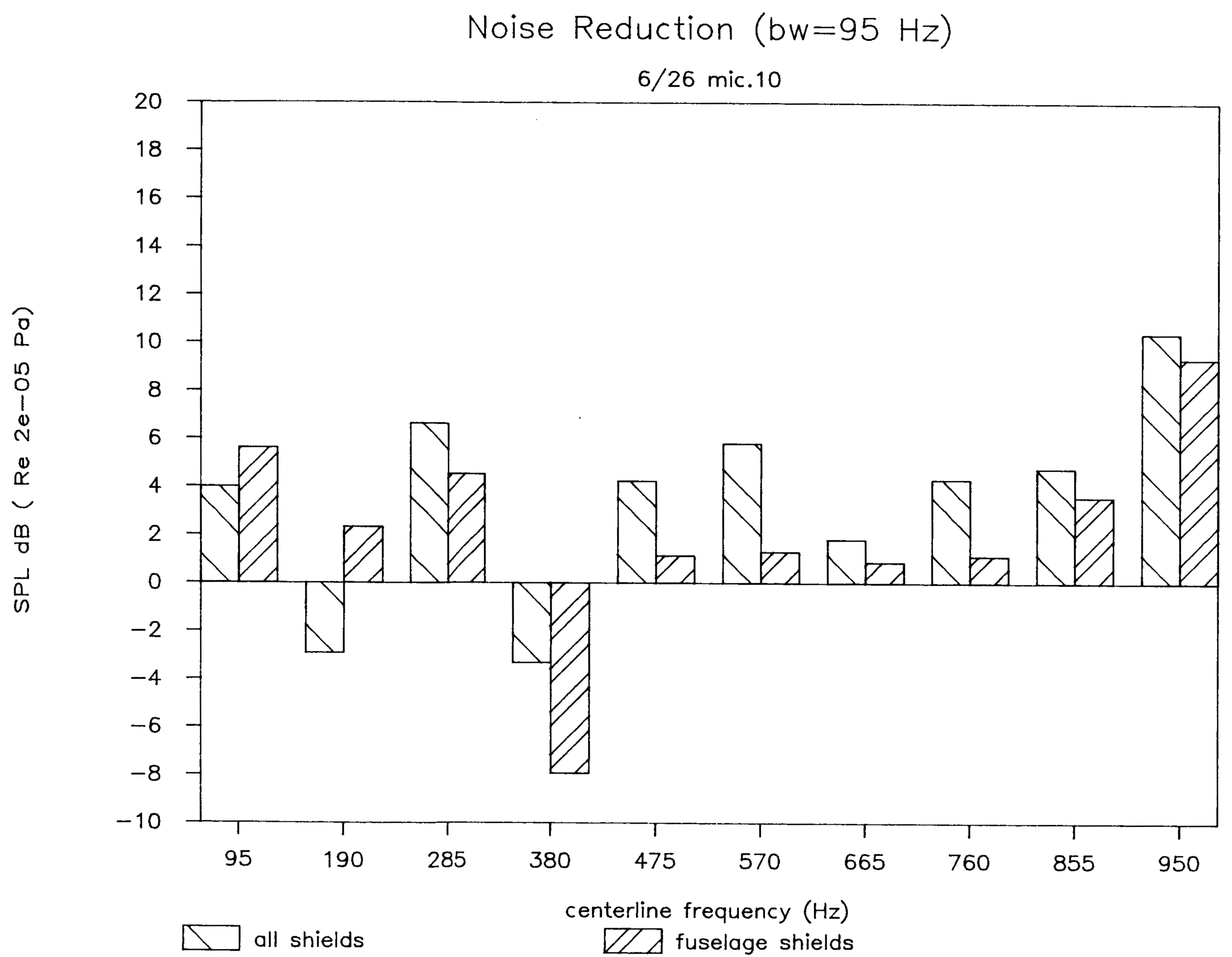
Noise Reduction (bw=95 Hz)
6/26 mic.7
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

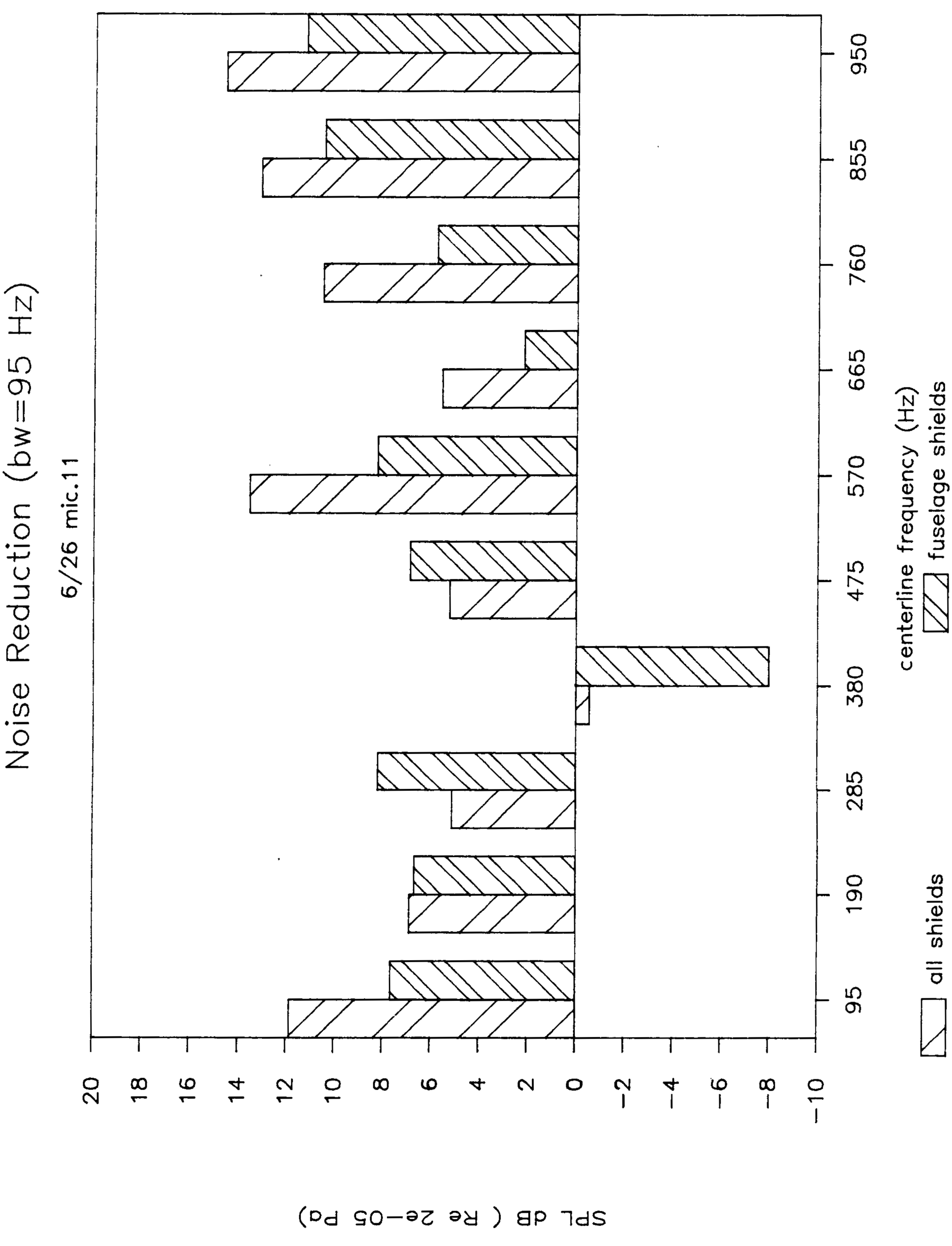


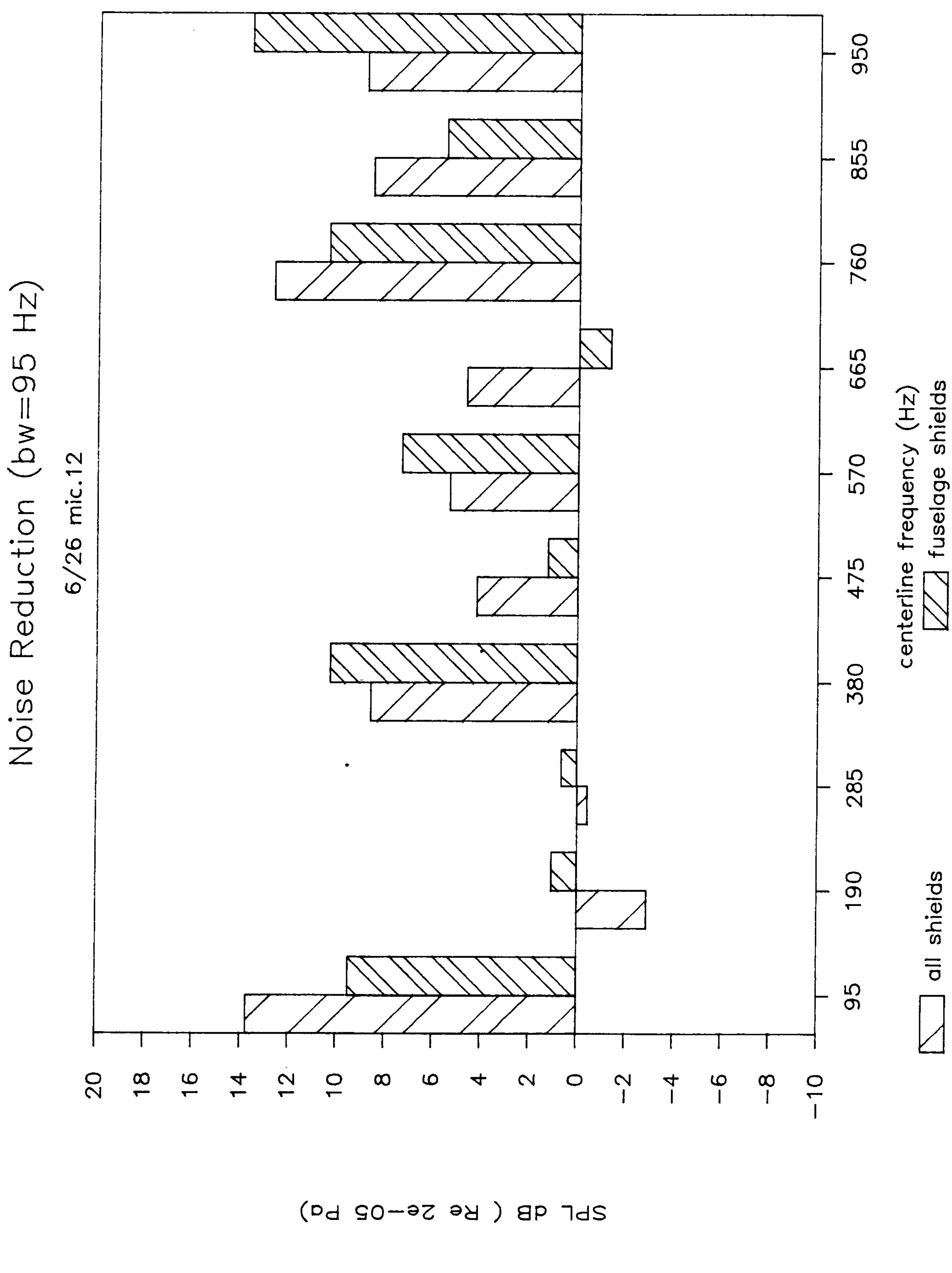
Noise Reduction (bw=95 Hz)
6/26 mic.8
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields



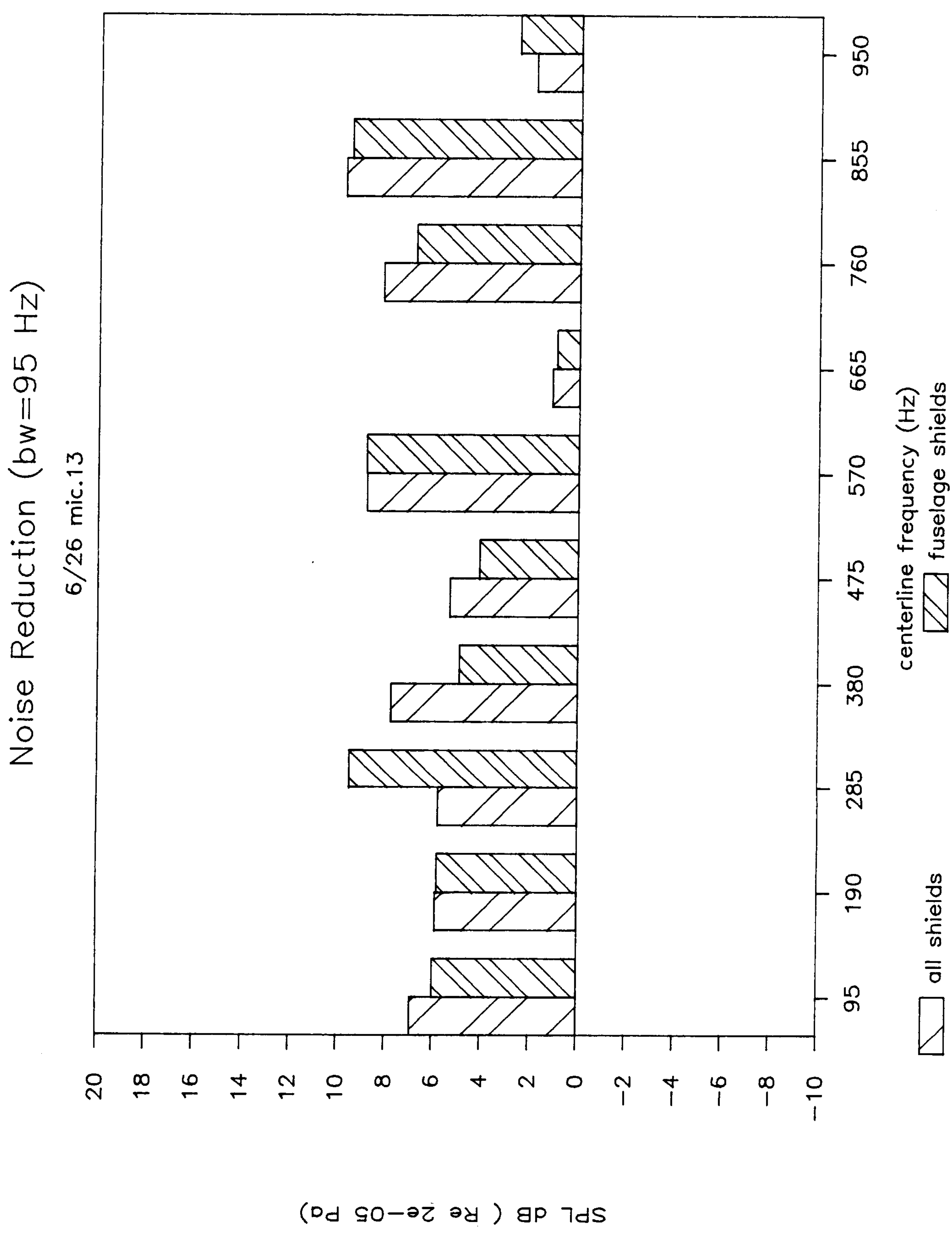
Noise Reduction (bw=95 Hz)
6/26 mic.9
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

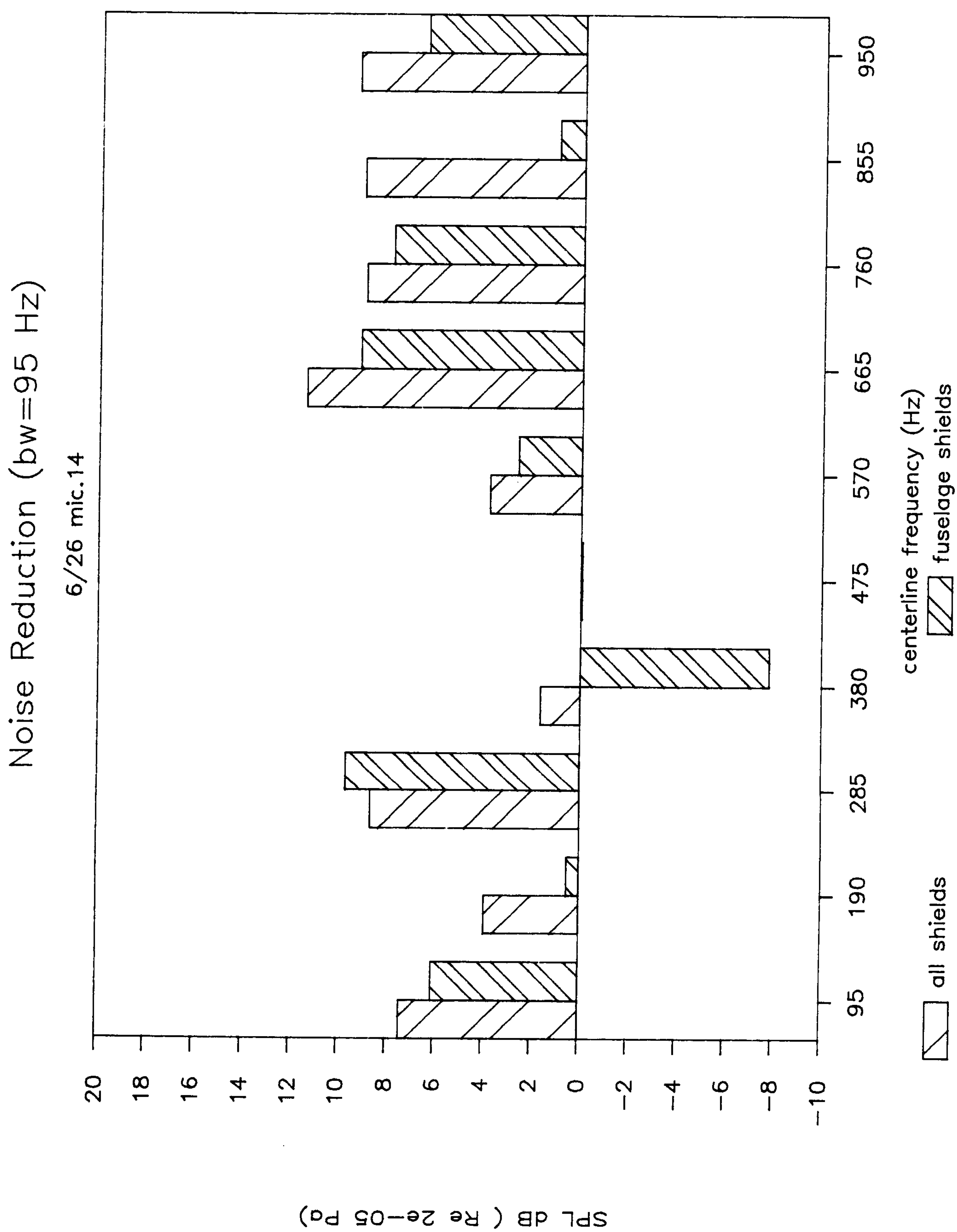

Noise Reduction (bw=95 Hz)
6/26 mic.10
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

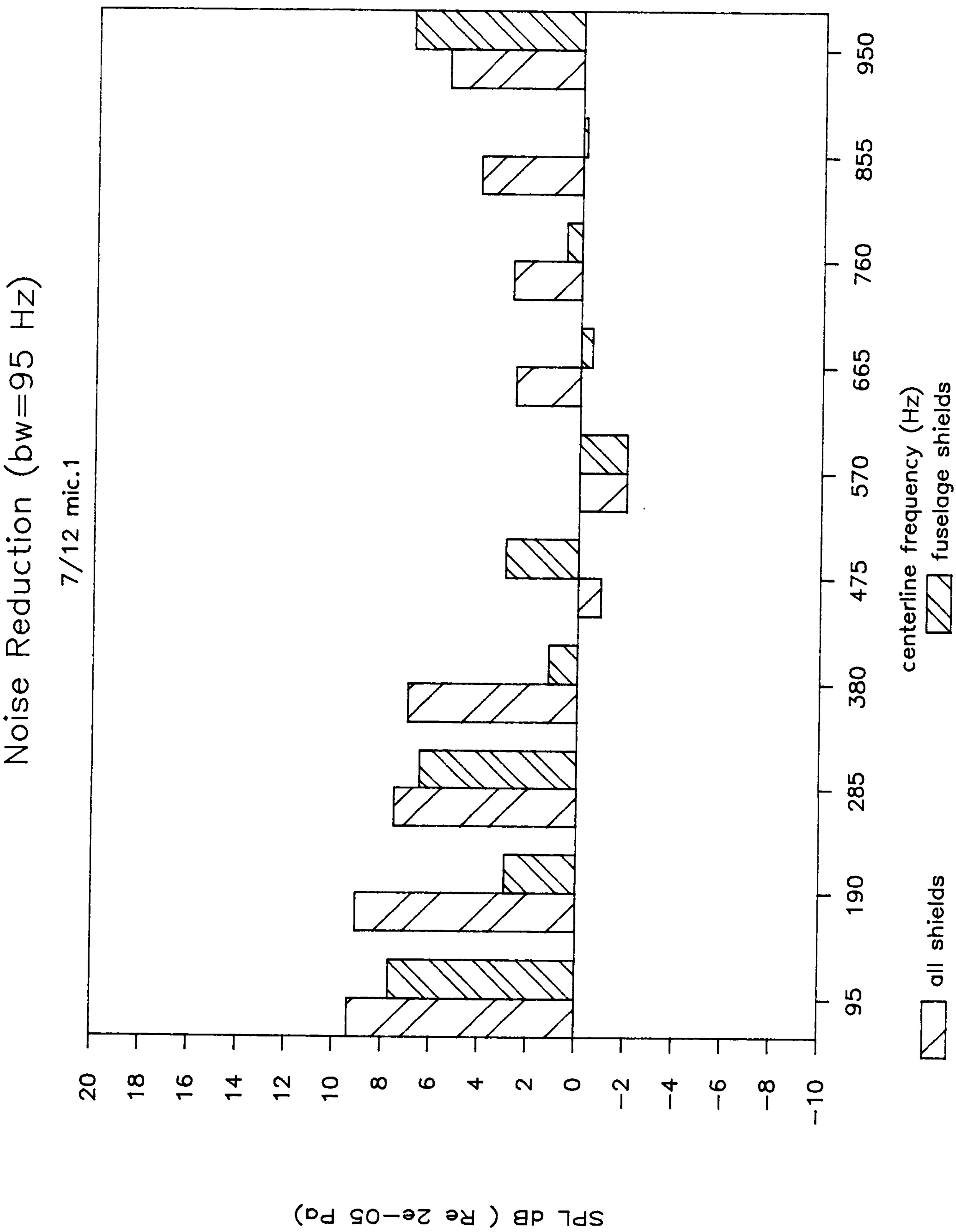

Noise Reduction (bw=95 Hz)
6/26 mic.11
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields



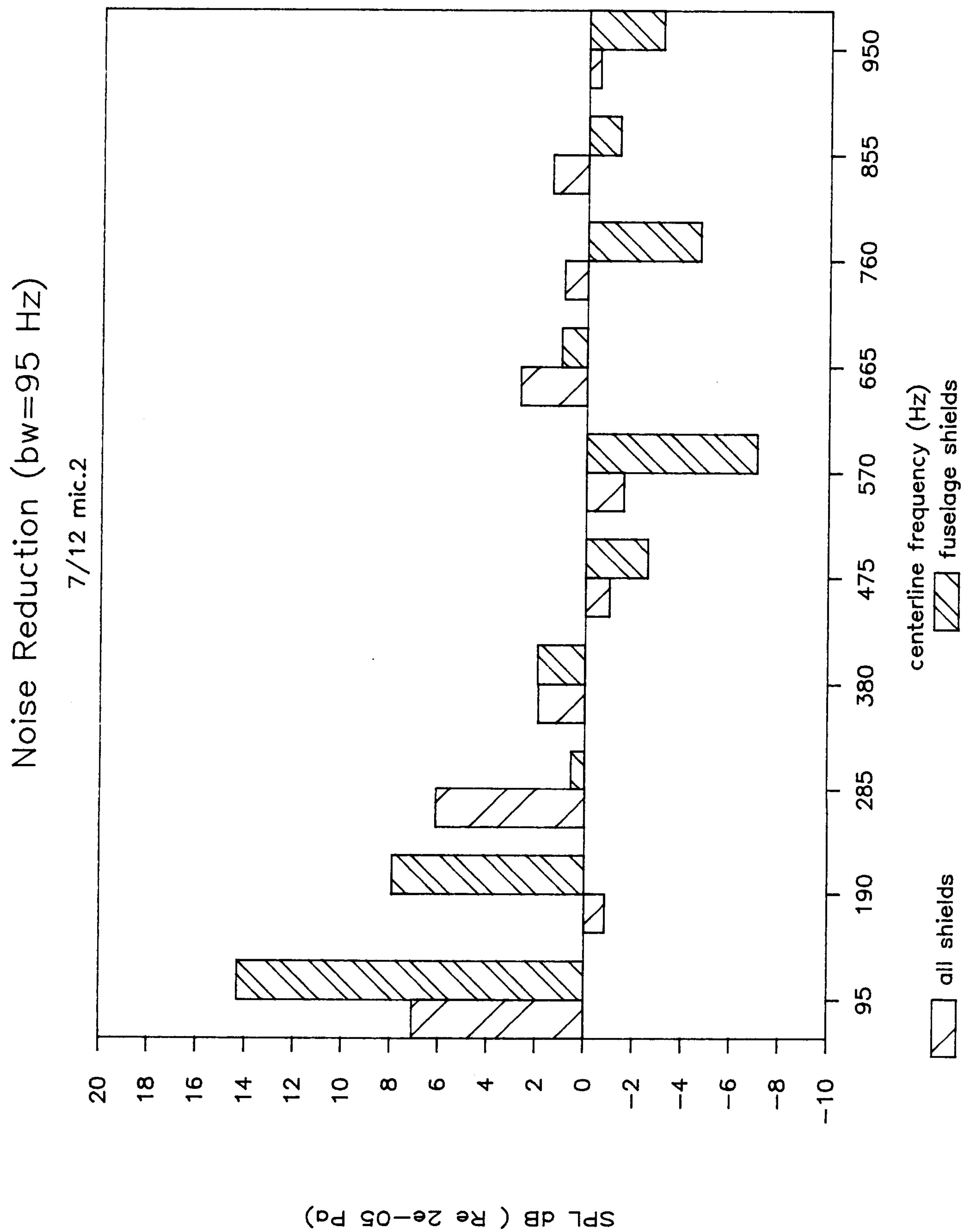
Noise Reduction (bw=95 Hz)
6/26 mic.12
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields

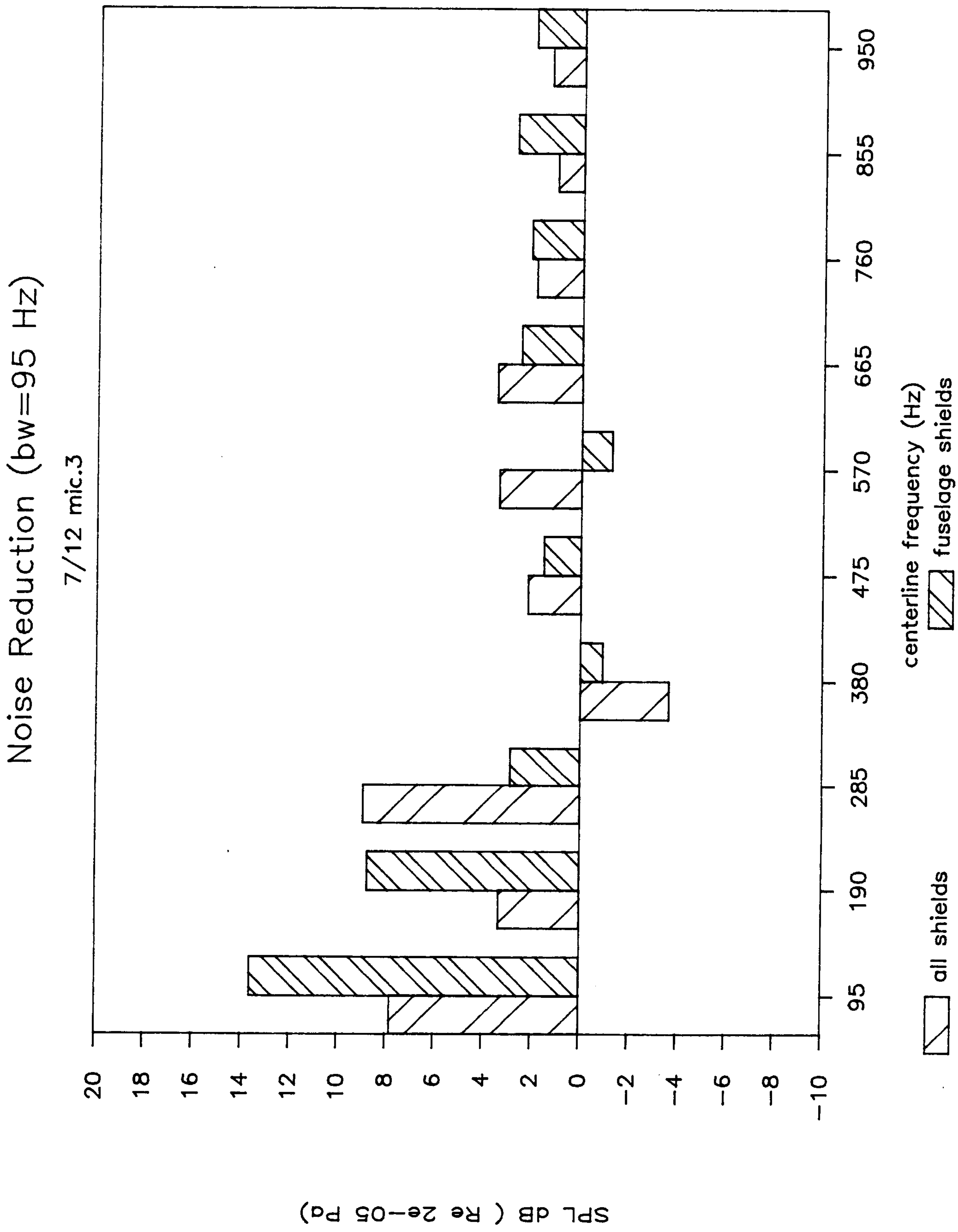

Noise Reduction (bw=95 Hz)
6/26 mic.13
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
6/26 mic.14
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields



Noise Reduction (bw=95 Hz)
7/12 mic.1
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.2
SPL dB (Re 2e−05 Pa)
20
18
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.3
SPL dB (Re 2e−05 Pa)
20
18
16
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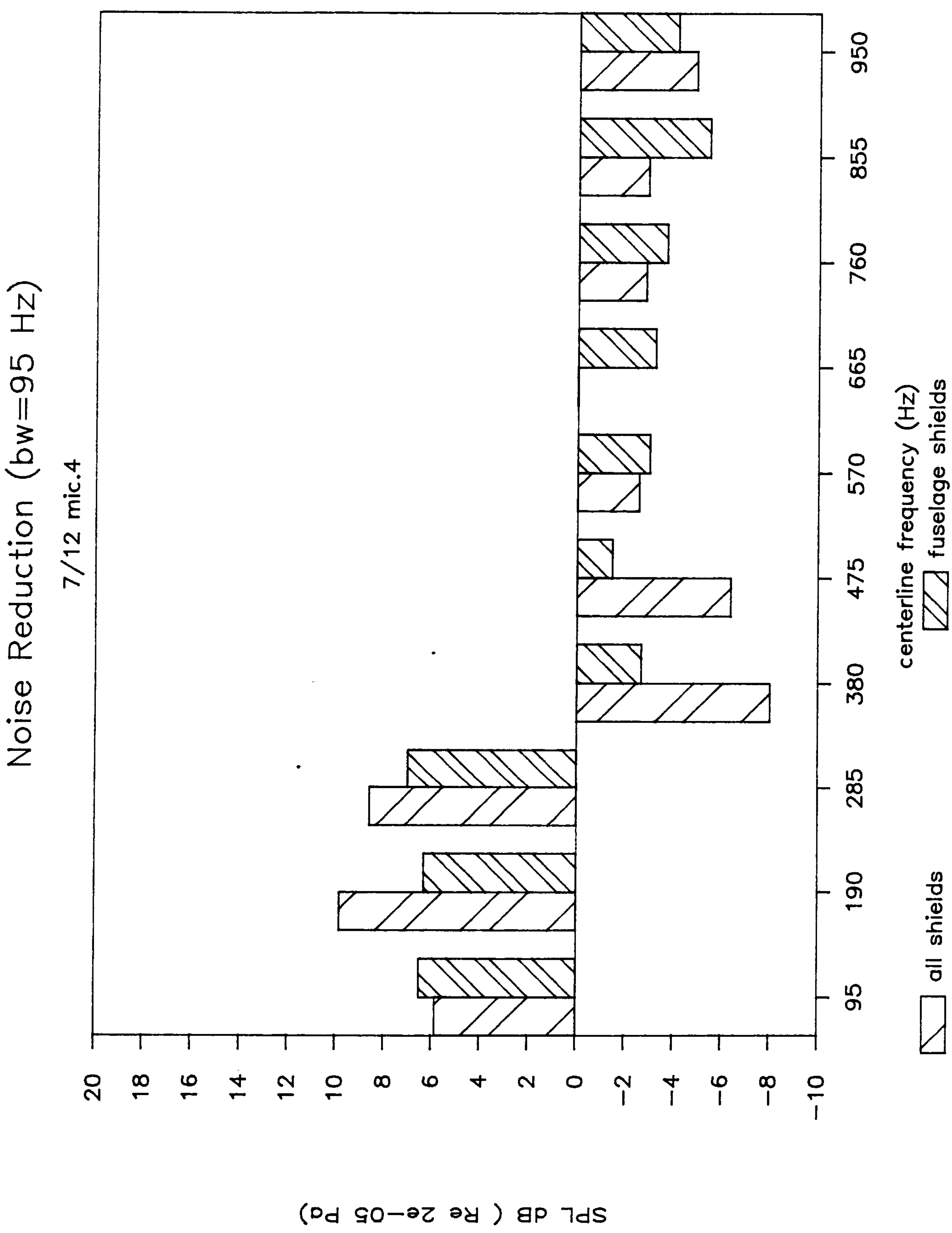
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.4
SPL dB (Re 2e-05 Pa)
20
18
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4
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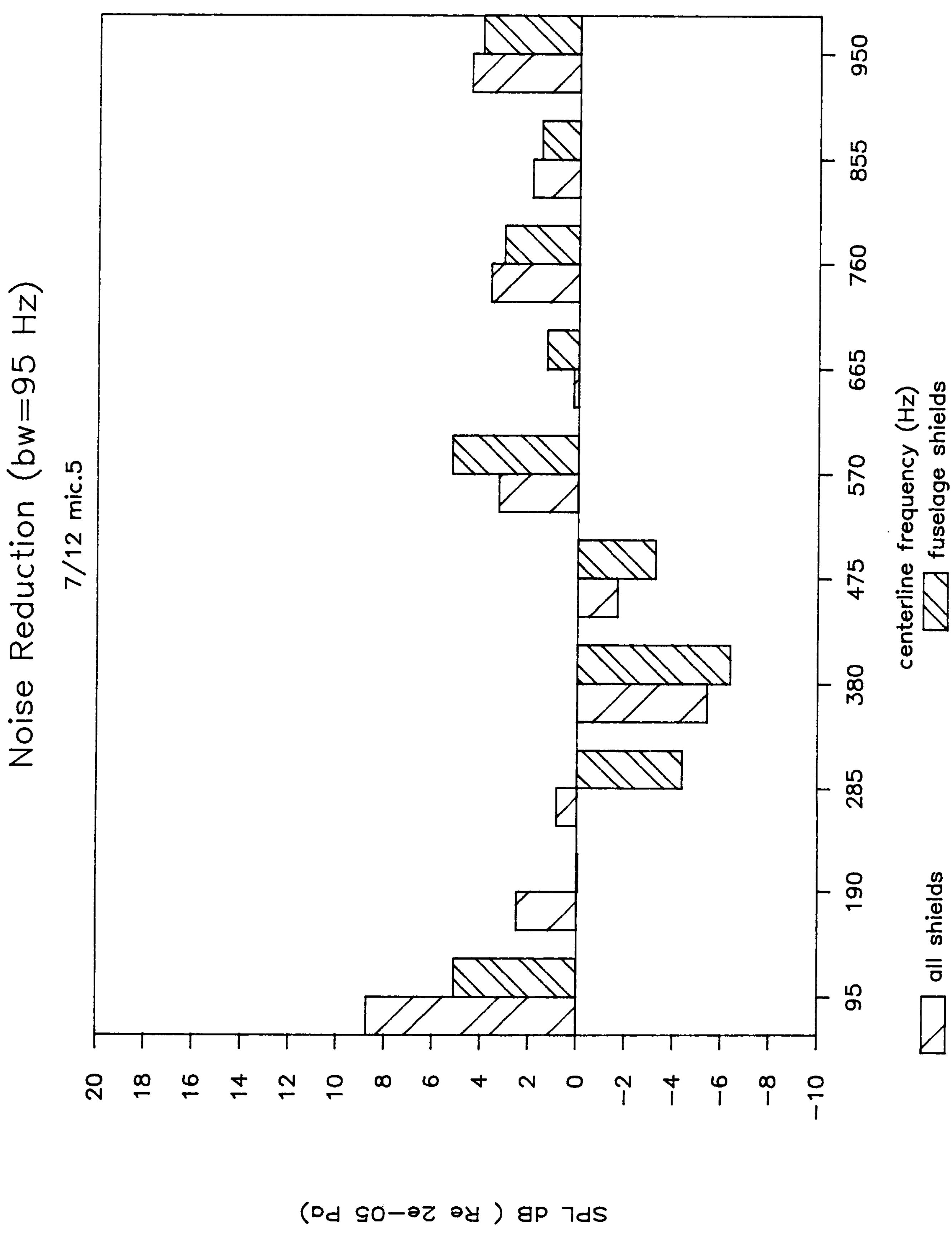
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.5
SPL dB (Re 2e-05 Pa)
20
18
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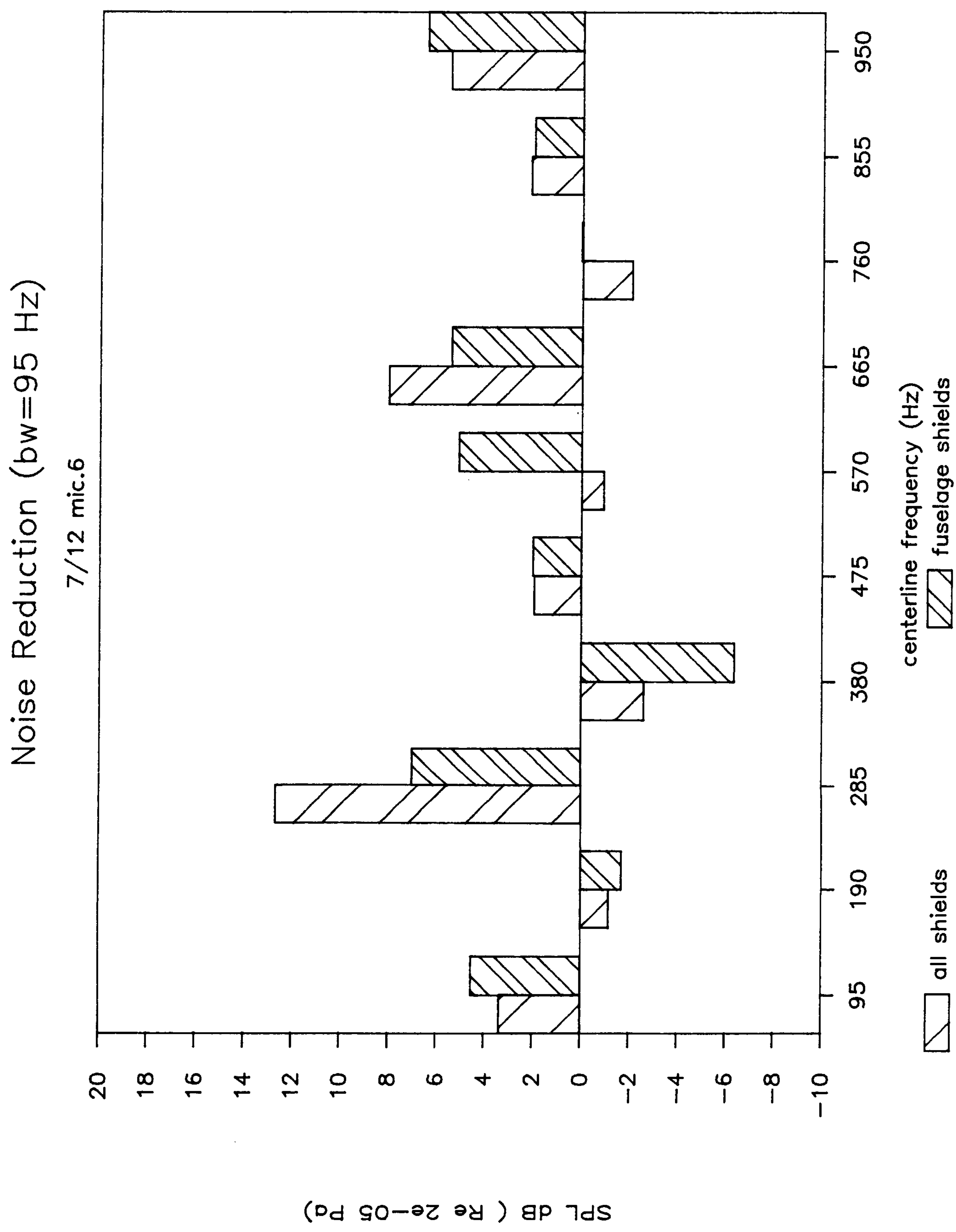
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.6
SPL dB (Re 2e-05 Pa)
20
18
16
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12
10
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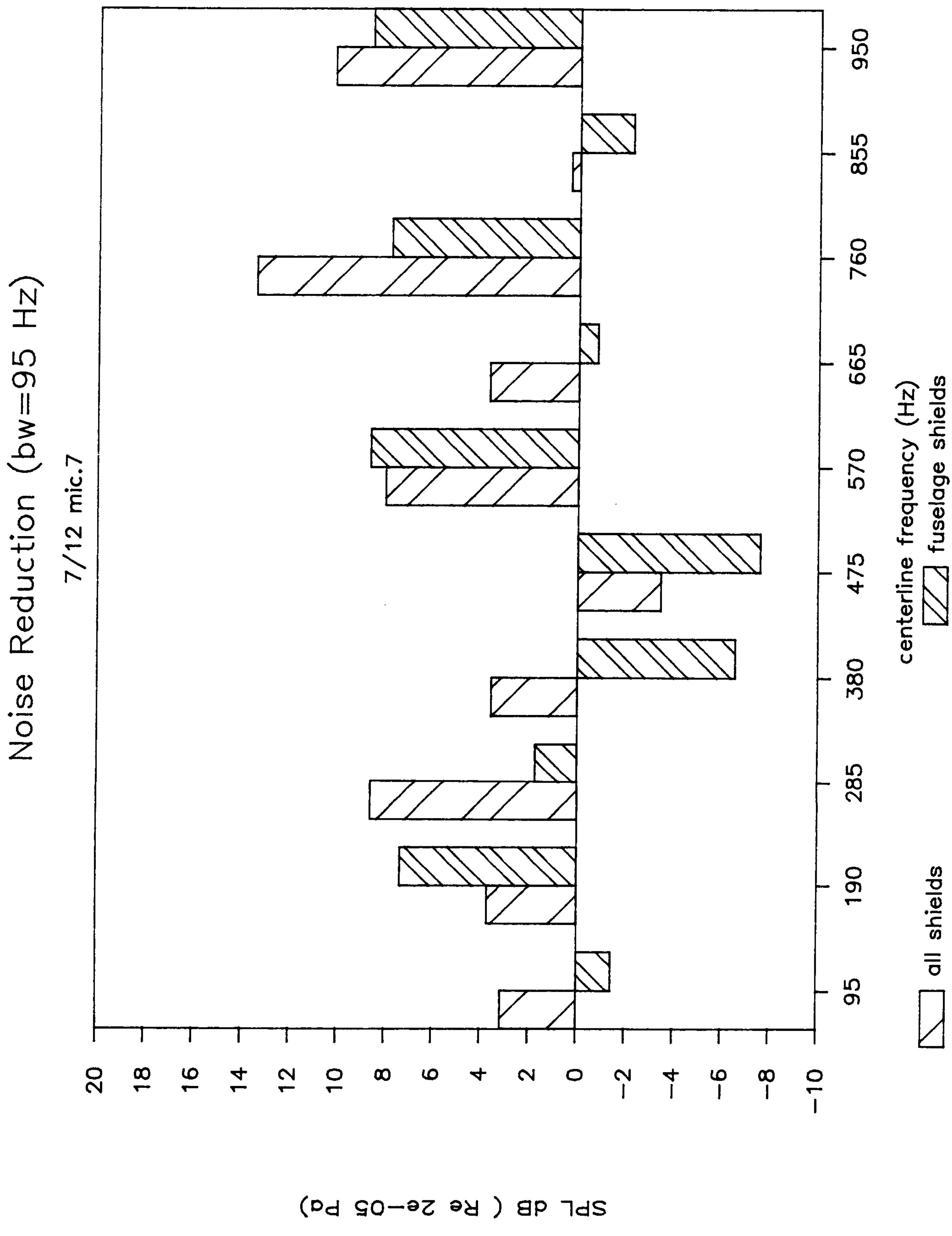
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.7
SPL dB (Re 2e-05 Pa)
20
18
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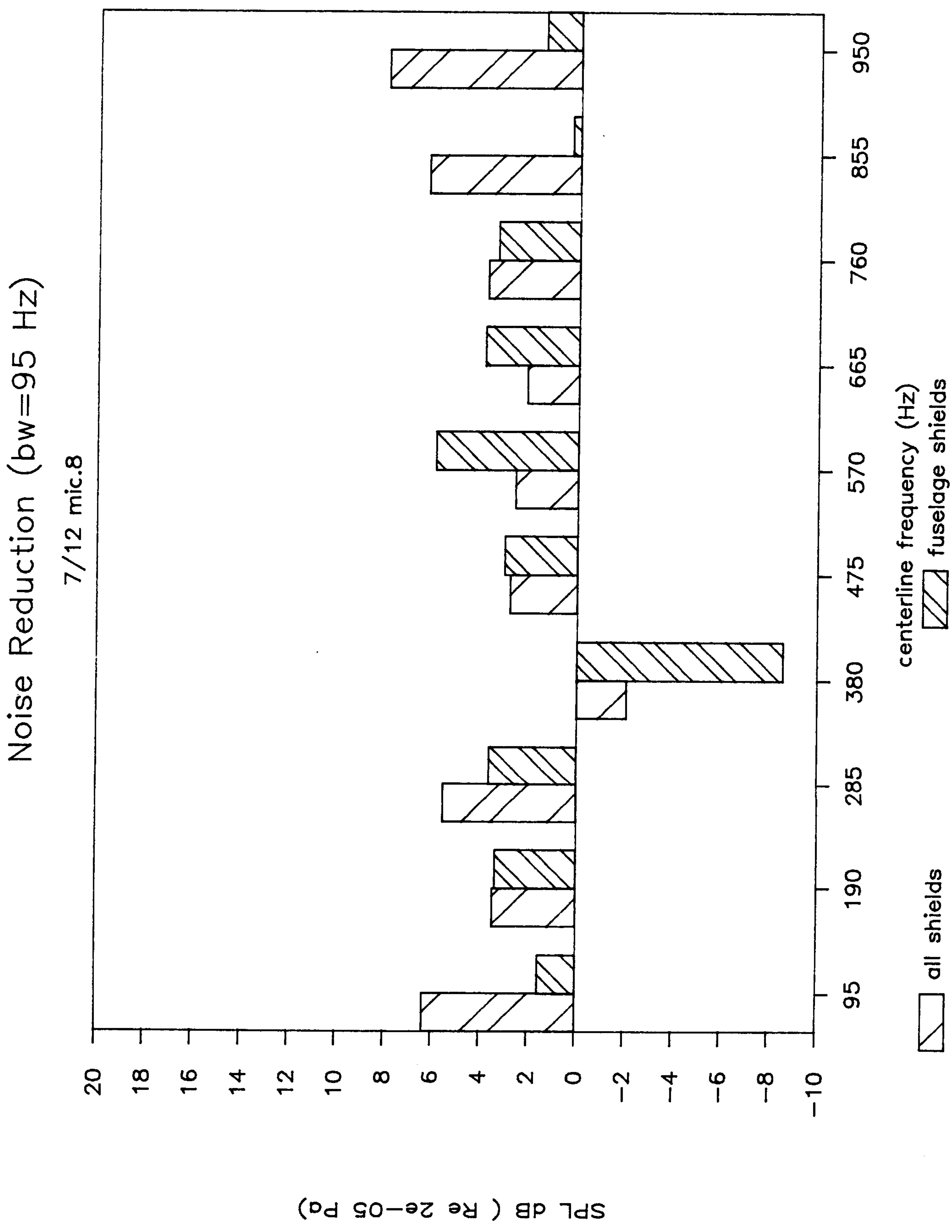
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.8
SPL dB (Re 2e-05 Pa)
20
18
16
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4
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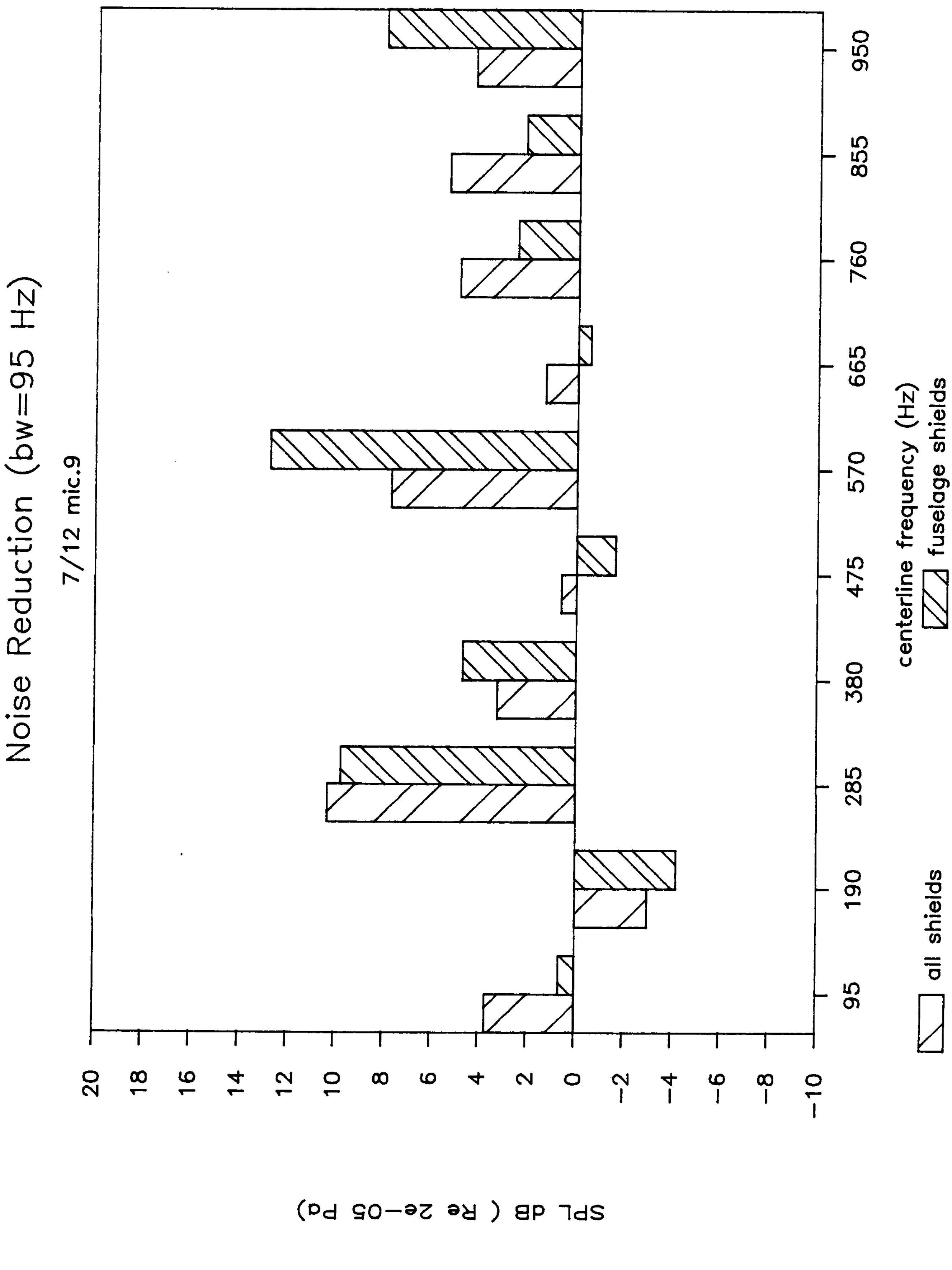
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.9
SPL dB (Re 2e-05 Pa)
20
18
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12
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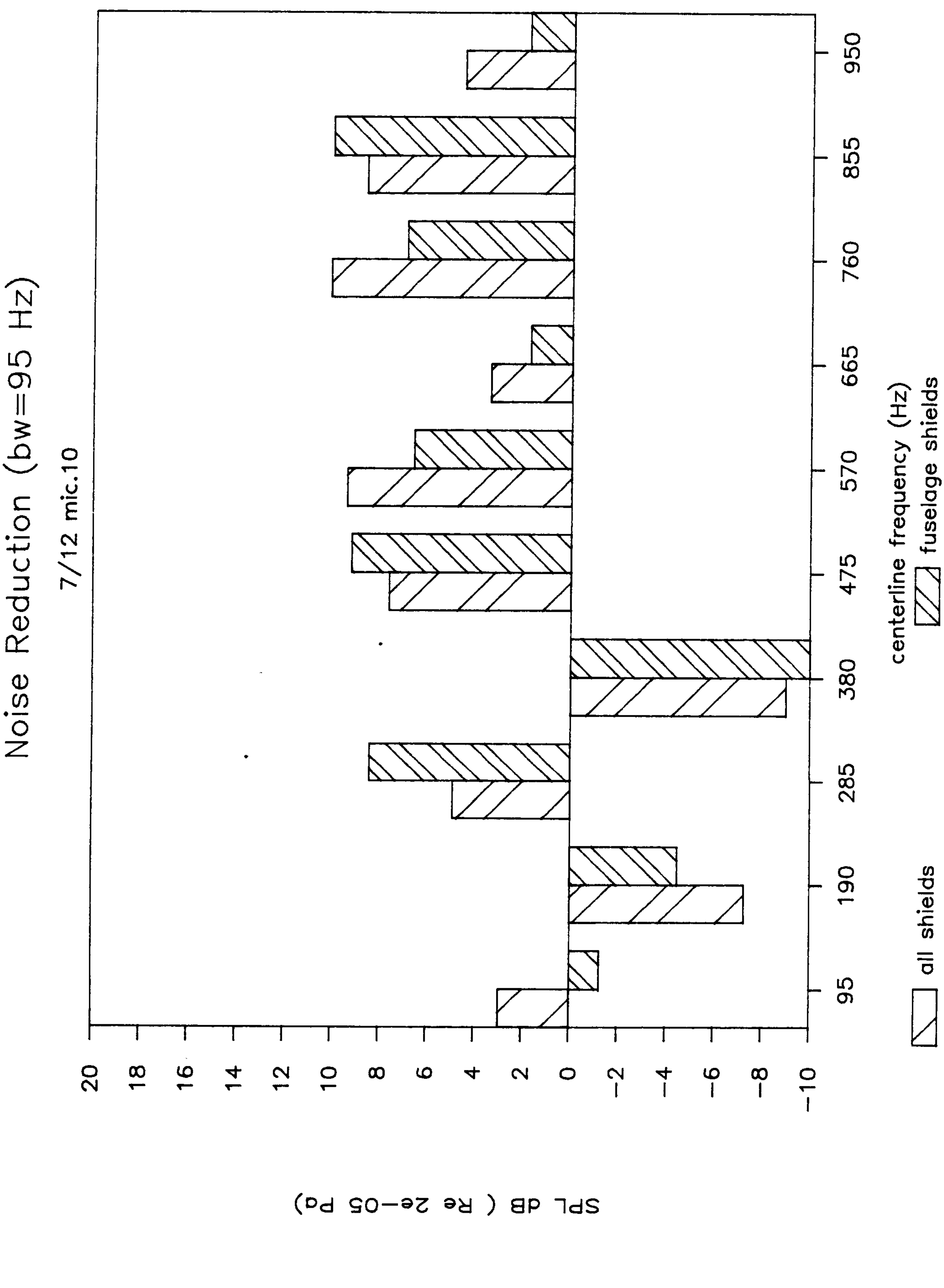
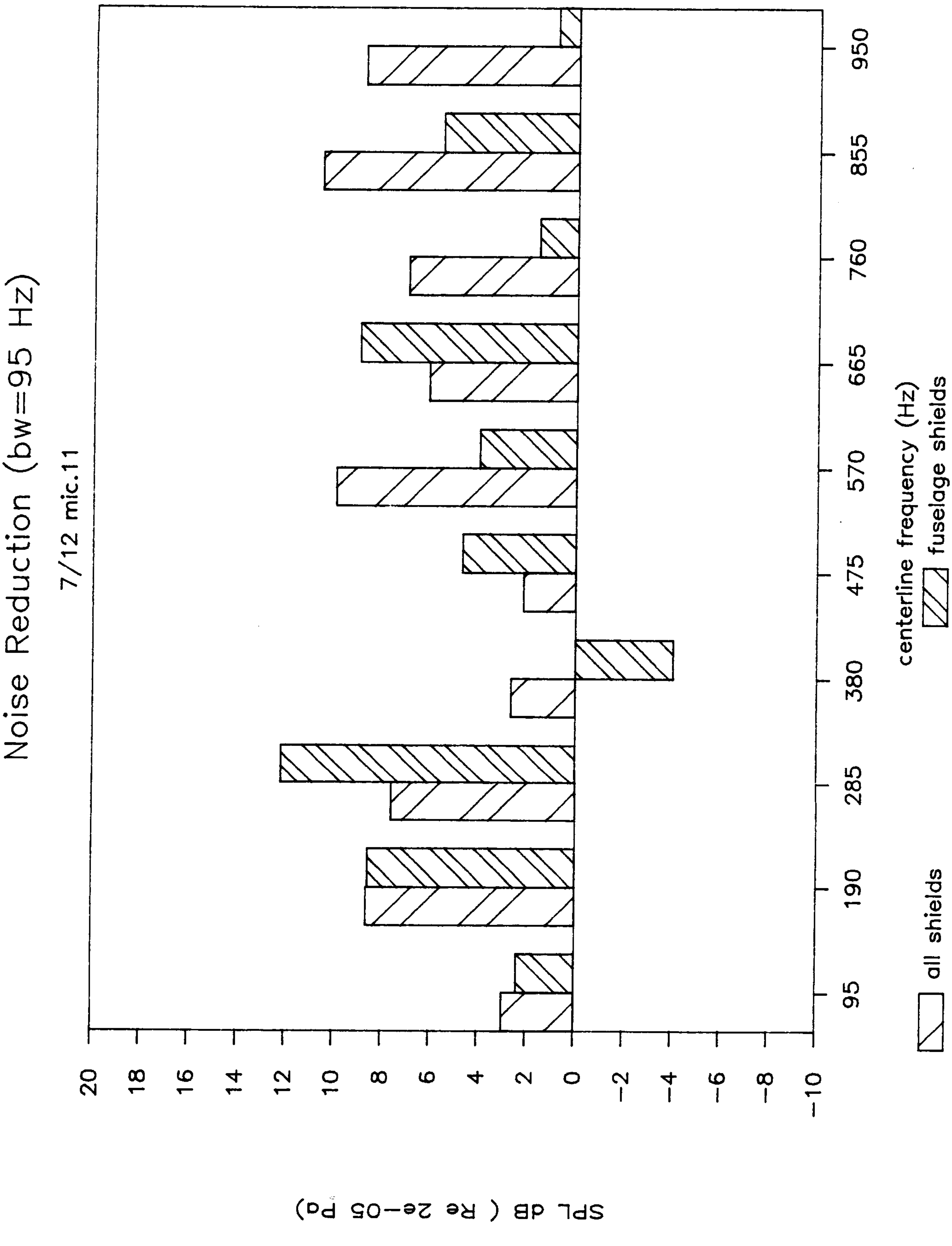
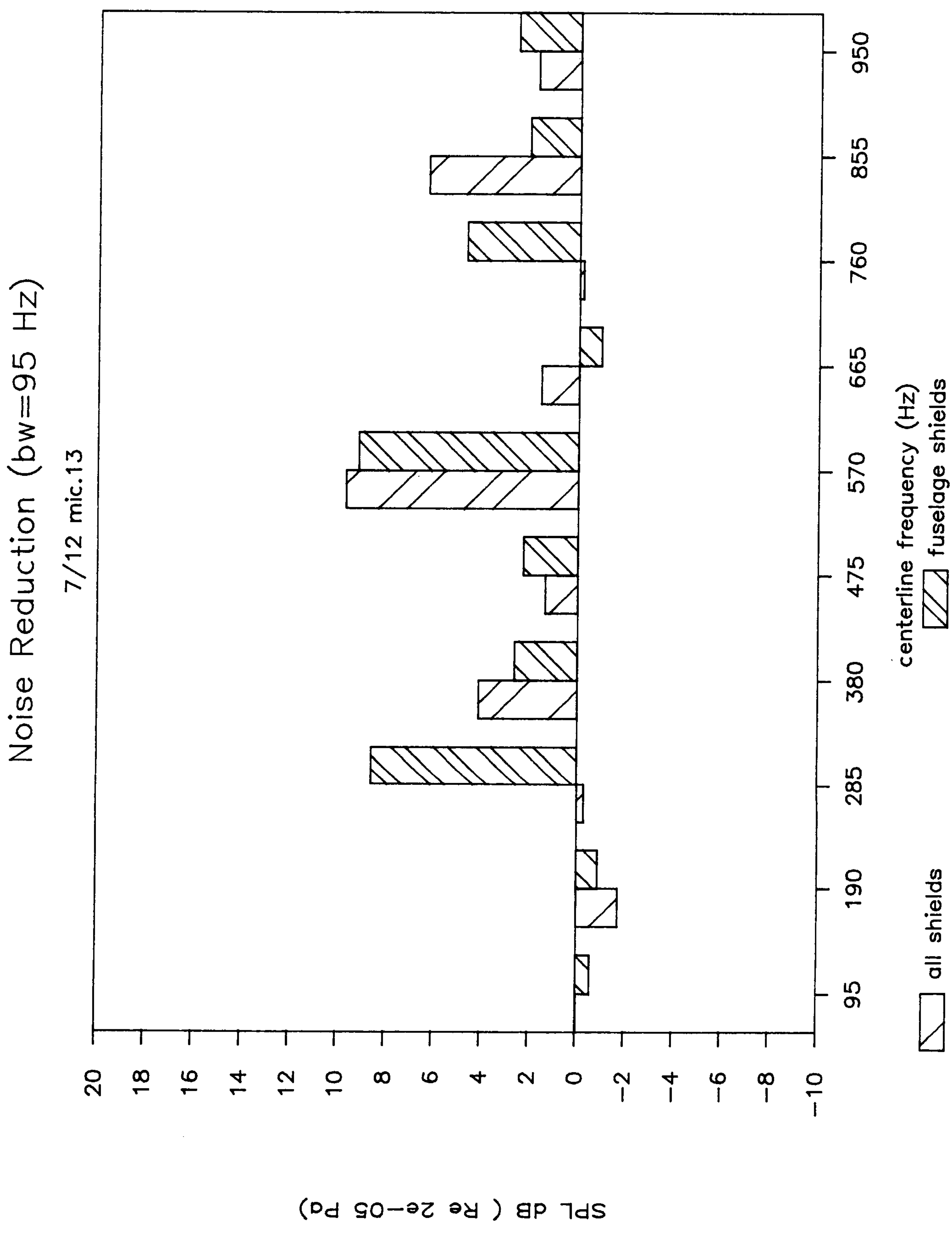
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields



Noise Reduction (bw=95 Hz)
7/12 mic.10
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.11
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields


Noise Reduction (bw=95 Hz)
7/12 mic.13
SPL dB (Re 2e-05 Pa)
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
95
190
285
380
475
570
665
760
855
950
centerline frequency (Hz)
all shields
fuselage shields